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ORIGINAL ARTICLES.

I.—On Some New or Imperfectly Known Madreporaria from the Inferior Oolite of Oxfordshire, Gloucestershire and Dorsetshire.

By Robert F. Tomes, Esq.

(PLATE X.)

In the thirty-eighth volume of the Quarterly Journal of the Geological Society is a paper by me on the Corals of the Inferior Oolite, and in the following volume is one on the Corals of the Great Oolite. The forty-first volume of the same periodical contains a supplement to the latter, but to the former no such addition has yet been made. The present communication makes good that deficiency, and is a supplement to it. It contains, besides the description of some new species, additional remarks on others already known, mention of genera about which doubt has been expressed, and the description of one which I consider new. Another genus, *Stephanocœnia*, though well known elsewhere, has up to the present time remained unrecognized as British, and is now introduced on the evidence of two well-marked species from the Inferior Oolite of Gloucestershire. The addition to our Coral fauna of such genera as the above, and of others equally well known which I have also had the opportunity of making known, is of even greater interest than the discovery of new genera and species. *Epismilia*, *Donacosmilia*, *Cyathophyllia*, *Adelastræa*, *Stylosmilia*, *Rhizangia*, *Thecoseris*, *Leptophyllia*, and *Enallohelia*, form a valuable contribution towards the Coral fauna of this country.

Three papers on Fossil Madreporaria have lately appeared from the pen of Professor Duncan, two of which are professedly criticisms on my own communications on the same subject. The title of the first is, "On the Astrocœniæ of the Sutton Stone and other Deposits of the Infra Lias of South Wales."

That of the second is, "On the Structure and Classificatory Position of some Madreporaria from the Secondary Strata of England and South Wales." Both these were read at the meeting of the Geological Society on the 4th November, 1885, and appeared in full in the Journal of the 1st of February, 1886. The third paper appears in the February Number of the Geological Magazine for the present year.

Of the first of these I have only at present to say that it is deserving of consideration, because it is based on the examination of authentic specimens, though whether the conclusions sought to be

maintained are substantiated is yet open to question. The purpose of the paper is to re-assert what I have objected to, namely, that the distant and cylindrical corallites of such compound and compact corals from the Sutton Stone and neighbouring conglomerates as have columellæ have become cylindrical by matter added to the walls themselves, and not by the interposition of true cœnenchyma, as in *Stylina* and other allied genera. To this I shall refer on some future occasion. Professor Duncan's third paper is an answer to one of mine on some Cretaceous Madreporaria, and the consideration of it may also remain over until another opportunity. But the second paper, as it relates principally to Oolitic genera and species, may be here discussed. I have not, however, the remotest intention of entering into a controversy on the many points on which Professor Duncan and I entertain opposite opinions. Controversy, when carried to the length it sometimes is, embarrasses the editor, is offensive to the reader, and lowers the tone of the periodical in which it appears—a consummation much to be regretted. With every wish, however, to avoid such an occurrence, I must claim the privilege of making known the conclusions to which my investigations have brought me, and of re-asserting or modifying from time to time, if I have good reason for doing so, any statement I may have made. But while doing this, it will be my most earnest wish to avoid the occurrence of anything which may seem captious or discourteous.

A great many of the objections raised by Professor Duncan against my several papers on the Madreporaria of our Secondary formations refer to mere matters of oversight, and as they do not affect the conclusions arrived at, are of little importance. They might prove useful on some future occasion in making corrections, were the papers to re-appear in a collective form. Objections of another kind take the form of direct and unsupported contradiction of facts, and there are again, some, which, from their very nature, and for the author's own sake, should be allowed to pass unnoticed. But such statements as affect the definition of genera and the determination of species, and have therefore a more legitimate bearing on the subject in hand, will receive due attention in their proper place.

A collection of specimens from the Inferior Oolite of Dorsetshire has lately been placed in my hands by Mr. Buckman, and these with others kindly supplied by Mr. Hudleston, with the addition of a collection made by me during a recent visit to the same district, have afforded me the long-wished-for opportunity of comparing the Dorsetshire and Somersetshire species with those from the counties of Oxford and Gloucester. A list of the Dorsetshire species will be given further on.

Diligent search has been made for Corals in the lowest beds of the Inferior Oolite at Crickley Hill, Leckhampton Hill, Cleeve Hill, and Frocester Hill, in consequence of the species already found in them having differed so materially from those in the more clearly defined coralliferous deposit overlying the Pisolite. They are, besides, interesting as being the earliest representatives of Madreporaria in the Oolitic formation, differing greatly in their facies

from the few small corals which are found in the Upper Lias, though not nearly so much from those species which occur in the underlying Marlstone. The following are such as have up to this time been taken from the Pisolite, and the beds below it.

Montlivaltia concinna.—Pisolite at Crickley and Leckhampton, and in the broken-up bottom beds at Huddiknoll, near the Horsepools, Gloucester.

Montlivaltia cupuliformis.—Beds under the Pisolite, Crickley.

Montlivaltia de la Bechei.—Bed under the equivalent of the Pisolite, Frocester Hill.

Montlivaltia lens.—Beds under the Pisolite at Leckhampton and Crickley, and in the beds overlying the Upper Lias sands, Dover's Hill, Chipping Campden.

Isastræa, an undetermined species.—Bed under Pisolite, Crickley.

Chorisastræa, sp.—Pisolite, Crickley, and the bed overlying the Upper Lias sands, Dover's Hill, Chipping Campden.

Thamnastræa, sp.—Pisolite, Crickley.

Thamnastræa, sp.—Bed overlying the Upper Lias Sands, Dover's Hill, Chipping Campden.

Oroseris Oolitica.—Bed under the Pisolite, Crickley.

Comoseris vermicularis.—Pisolite ? Crickley.

Several of the above are either undeterminable or have already been passed under review, but mention will hereafter be made of some of them in the notes on the species.

Mr. Witchell, in his valuable work on the Geology of Stroud, records the occurrence of a Coral-bed resting on the Upper Trigonia Grit. The position being wholly at variance with that assigned to the Upper Coral-bed near Cheltenham by the late Dr. Wright, I have recently visited Stroud, and, under the guidance of Mr. Witchell, have examined one of the sections mentioned by him—the Stroud Hill section. The result has been the full confirmation of his opinion, that there are four coralliferous deposits in the Inferior Oolite of Gloucestershire, instead of three as stated by the late Dr. Wright. The Coral-bed exposed in Worden's quarry in the Slad Valley, Stroud, though supposed by Dr. Wright to correspond with the upper one near Cheltenham, is really of more recent date, and is indeed the same as the one in the Rodborough Hill and Stroud Hill sections. The position of these four coralliferous layers in the Inferior Oolite of Gloucestershire may be defined as follows :—

1. *The Upper Coral Bed.*—Occurs in the upper part of the Upper Trigonia Grit, and is exposed at Rodborough Hill, Stroud Hill, and in the Slad Valley, near Stroud.
2. *The Second Coral Bed.*—Lies in the bottom of the Lower Trigonia Grit, and is exposed at Cleeve Hill, Leckhampton Hill, Ravensgate Hill, Brown's Hill near Seven Springs, Juniper Hill near Painswick, and at Birdlip, all localities in the Cheltenham district.
3. *The Third Coral Bed.*—Lies in the Oolite Marl at Birdlip Hill, Leckhampton Hill, Juniper Hill, and at Notgrove on the Cheltenham and Chipping Norton Railway.
4. *The Fourth Coral Bed.*—Lies directly upon the Pisolite, and is well exposed at Crickley Hill, Birdlip Hill, Sheepscombe, the Horsepools, at Huddiknoll, and at Juniper Hill near Painswick. It is absent at Cleeve Hill and at the Leckhampton and Frocester Hills.

The Corals of Beds 2, 3 and 4 have already received attention, but those of Bed No. 1, have not been made known. It appears, however, to be very poor in species, only three having as yet been noted. They are, *Isastræa tenuistriata*, *Isastræa* sp. undetermined, and *Thamnastræa* sp. undetermined.

The following are the species from the Inferior Oolite of the counties of Dorset and Somerset which I have met with up to the present time, with their several localities, and, as far as determined, their Ammonite zones.

Discocyathus Eudesi. Burton Bradstock, probably in the zone of *Ammonites Parkinsoni*; Corton Denham, Somerset, in the zone of *Am. Murchisoni.*

Trochocyathus magnevillianus. Half-way house near Yeovil, in the zone of *Am. Parkinsoni;* under cliff, Burton Bradstock, probably in the same zone; in the "Marl Bed" at Bradford Abbas, in the bottom of the zone of *Am. Parkinsoni.*

Trochocyathus sp. A small conical species not yet determined, obtained by Mr. S. S. Buckman from the Bradford Abbas quarry, but the position not recorded.

Thecocyathus discus, E. de From. Burton Bradstock, the zone not noted, but associated with specimens of *Discocyathus Eudesi*, which were stated to have been taken from the zone of *Am. Parkinsoni.*

Thecocyathus, a species undetermined, obtained from the "Marl Bed" at Bradford Abbas by Mr. Buckman.

Montlivaltia lens. Bradford Abbas railway-cutting, in the zone of *Am. Murchisoni*, immediately overlying the sands; Castle Cary Hill in the zone of *Am. Parkinsoni*; Corton Denham, Somerset, in the zone of *Am. Murchisoni*; and in the zone of *Am. Sowerbyi*, at Bradford Abbas.

Montlivaltia de la Bechei. Bradford Abbas railway-cutting, in the zone of *Am. Murchisoni*; Drimpton near Broadwinsor, Dorset, in the zone of *Am. Parkinsoni*; Castle Cary Hill, Somerset, in the zone of *Am. Parkinsoni*; Bridport, the zone not noted.

Montlivaltia tenuilamellosa. A single specimen has been sent to me labelled Bradford Abbas, but it has more the appearance and colour of Burton Bradstock specimens.

Montlivaltia cupuliformis. Bradford Abbas, in the paving-bed at the top of the zone of *Am. Murchisoni*, where it is not uncommon.

Montlivaltia sp., undetermined, occurs with the last, and may perhaps prove to be identical with it.

Isastræa, sp. Not determinable. From the paving-bed at Bradford Abbas.

Latimœandra Flemingi ? A species very nearly allied to, or identical with this, occurs in the paving-bed at Bradford Abbas, and is remarkable from having a thick and wrinkled epitheca.

——— ? A compound coral having calices in shape like those of an *Isastræa*, with confluent septa, and a columella, occurs at Bradford Abbas, but the zone has not been determined.

Thecoseris polymorpha. Several small specimens referable to this species have been taken from the paving-bed at Bradford Abbas, and I have one from the Inferior Oolite at Stoford, Somerset.

Leptophyllia, sp. (*Podoseris constricta*, Duncan). The type-specimen of *Podoseris constricta*, which was for some time in my hands, has so much the appearance of the Burton Bradstock specimens that I have no doubt that it was obtained from that place. It is stated to have come from the Lower Ragstone of Dorset, which I presume is the zone of *Am. Parkinsoni*, the zone from which the other Burton Bradstock Corals here mentioned have been obtained.

Thamnastræa Defranciana. A single example from the Inferior Oolite of Dorset is in my collection, but I do not know either its zone or exact locality.

Dimorpharæa Oolitica, Duncan, sp. Occurs at East Coker, and is common; also at Stoford near Yeovil, in the zone of *Am. Sowerbyi*.

Dimorpharæa Beanii (*Cyclolites Beanii*, Duncan). Occurs in the paving-bed of the Bradford Abbas quarry, in the upper part of the zone of *Am. Murchisoni*.

Dimorpharæa expansa, n.s. East Coker, the zone not ascertained.

Microsolena, a small globular species. Two examples have been met with, one from the paving-bed at Bradford Abbas, and the other, although said to have been collected at the same place, has so much the appearance and colour of the Burton Bradstock Corals as to leave little doubt that it came from there.

The number of *Turbinolidæ* in the above list, occurring so low down in the Inferior Oolite of Dorset and Somerset, is rather remarkable, and would seem to indicate a continuous period from the Upper Lias upwards, the conditions of which were favourable to the growth of these small Madreporaria, and which did not prevail during the formation of corresponding deposits in the Gloucestershire and Oxfordshire areas. The general resemblance between the *Turbinolidæ* of the Upper Lias and those of the Inferior Oolite of the Western Counties of England is very obvious.

The following section at present exposed in the quarry at Bradford Abbas was taken by me a few months since, and although it does not materially differ from those already given by Mr. S. S. Buckman[1] and Mr. Hudleston,[2] is repeated here for the purpose of showing all the more correctly the position of the Corals in it.

	ft.	in.
1. Surface soil	0	6
2. Shattered stone and rubble	3	6
3. Stone in nodular layers, divided by thin irregular layers of marly shale	4	0
4. Soft stone	0	8
5. Marly shale; the "Marl bed" of S. S. Buckman. Contains *Trochocyathus magnevillianus*	0	2
6. Gasteropoda bed, consisting of hard subcrystalline stone, which is thin and ragged and blue in the middle. It is overlain by a soft friable layer. It contains Gasteropoda of great beauty, and a considerable number of small sponges	0	9
7. Yellowish compact limestone	2	0
8. Paving-bed, containing the following corals: — *Montlivaltia cupuliformis*, *M. lens* and another species undetermined, *Latimæandra Flemingi*, a compound coral allied to *Isastræa*,		

[1] Quart. Journ. Geol. Soc. vol. xxvi. p. 591.
[2] Proceed. Geol. Assoc. 1885, p. 198.

	ft.	in.
Thecoseris polymorpha, *Dimorpharæa Beanii*, and a species of *Microsolena*	0	8
9. Dewbed, forming the bottom of the quarry, and lying on the Midford Sands. Depth not ascertained, more than	1	0

I now proceed to notice such species of corals from the Inferior Oolite as appear to be either undescribed, new to this country, or as demanding further remark.

THECOCYATHUS DISCUS. From. et Fer., Paléont. Franc. Polyp. Terr. Jurass. p. 34, pl. 2, fig. 2.

I have received a specimen of this species said to have been obtained from Bradford Abbas, but which, from its colour and lithological condition, most likely comes from the same horizon and place as a number of specimens of *Discocyathus Eudesi*, that is to say, from Burton Bradstock.

EPISMILIA PORPITA, Tomes,

Montlivaltia porpita, Tomes, Quart. Journ. Geol. Soc. vol. xxxviii. p. 419, 1882.

The small Corals I described under the name of *Montlivaltia porpita*, as having very peculiar septa, have proved, when some of their septa were exposed by the removal of others, to have their sides ornamented by tubercles instead of vertical ridges. These tubercles are ranged in rows, which are parallel to the edge of the septa, and when the latter have been worn down, the upper row on either side comes close to the top, and the septa, which are in reality very thin, are rendered thick and rugged by them. Until fully exposed, they were mistaken for the upper ends of vertical ridges.

The genus *Epismilia* is one about which there has always been some doubt, attributable probably to the difficulty attending its determination from *Montlivaltia*. M. de Fromentel proposed it, and it was clearly recognized as distinct by M. Etallon, under the name of *Ellipsosmilia*, D'Orb. Thurman, Fromentel and Ferry, knew and made use of the differences between it and *Montlivaltia*, and so did Stoliczka, while Milaschewitsch not only adopted it, but pointed out a character by which it could more easily be recognized. He showed that the septa have small tubercules on their sides instead of ridges, and Prof. Koby, availing himself of that means of determination, has described ten species as occurring in the Jurassic deposits of Switzerland.

To the description I formerly gave of the present species, under the name of *Montlivaltia porpita*, I need only add the above. Though confident of the existence of the genus *Epismilia* in our Oolites, I could not determine the species when I wrote my former paper. One species may now, however, with certainty be introduced into our Coral fauna.

DONACOSMILIA WRIGHTI, Edw. and Haime sp.

This common species occurs in the lower or fourth Coral bed wherever it is exposed in the Cheltenham district, as well as in the third Coral bed at Leckhampton Hill. Crickley Hill has, however, supplied all the best specimens, and they show that it is a tall

species, the corallites of which are placed close to each other. Many well-preserved calices have now been examined, and the generic characteristics fully made out. Prof. Duncan assumes that the simple corallum of *Axosmilia Wrighti* has been taken by me as the footstalk of *Donacosmilia*, but I never for a moment entertained such a supposition. On the contrary, I distinctly stated my belief that both *Axosmilia Wrighti* and *Montlivaltia Holli* were nothing more than single corallites of *Donacosmilia* broken off at their point of attachment to the parent stem, and I have seen nothing to induce me to modify that conclusion. The entire margins of the septa, which are so peculiarly characteristic and common to all the above-mentioned forms, are not so much as alluded to by Prof. Duncan in his late paper.

PLACOPHYLLIA GRACILIS, sp. nov. (Plate X. Figs. 5 and 6.)

Single corallites of a Coral having a gracile growth, and almost always in an indifferent state of preservation, have frequently been found in the Lower Coral-bed of the Cotteswolds. These could not be attributed to any known species, and were too fragmentary for description. Renewed search at those places where that Coral-bed is exposed has brought to light some better-preserved specimens, which may be described as follows :—

The corallum consists of a bush-shaped mass of rather closely placed and nearly parallel corallites, which have nearly the same diameter from the bottom to the top. Lateral gemmation takes places at considerable intervals, and the young corallites thus produced spring from the parent-stem horizontally, but speedily assume a perpendicular position by the side of the older corallite, and both grow upwards together. All the corallites, old and young, have a well-developed epitheca, which presents numerous and regular rings of growth. The walls are produced upwards, and with their epithecal covering, form thin and prominent margins to the calices.

The calices are ovoid and deep, and the fossula is elongated. The margins of the septa have very little curvature, but slope inward and downward in nearly a straight line. At the wall the septa are thick, but they diminish in thickness, and become quite thin as they approach the columella; though there is sometimes a little thinning just at their union with it. They are twenty-four in number, that is to say, three cycles in six systems. The first and second cycles are united to the columella, and two of the primary ones run into its two ends, and with it divide the calice longitudinally in half. The septa of the third cycle are three-fourths the length of the primary and secondary ones. There are a few rudimentary septa of the fourth cycle in some of the systems. The columella is thin, well defined, but not prominent, and is about one-third the entire length of the calice.

Diameter of the corallites from two to three lines. Their height cannot be ascertained.

This species bears considerable resemblance to the *Placophyllia rugosa* of Becker, from the Corallien of Nattheim.

STEPHANOCŒNIA DENDROIDEA, sp. nov. (Plate X. Fig. 10.)

I have long been familiar with fragments of a tall dendroid Coral from the Oolite Marl of Leckhampton Hill, which had characters I could not associate with any other Oolitic species, but which were too ill-preserved for identification. Some well-preserved pieces of a large specimen from Birdlip Hill, also from the Oolite Marl, having lately come into my hands, I am now able to describe this species as follows:—

The corallum is tall and branching, and attains to a height of a foot, or a foot and a half, and has very much the habit of growth of *Thamnastræa Lyelli*. The basal part has sometimes a diameter of as much as two inches, the horizontal section of which, as well as that of the branches, is nearly round, but they are nevertheless considerably nodulated.

The calices are evenly distributed, but are a little more distant from each other in the longitudinal direction of the branches. They are for the most part lozenge-shaped, ovoid, or even quadrangular; but the largest have a rounded outline, and there is a delicate but distinct line of depression between them. They are superficial, but have a circular and open centre.

The septa are short and stout, and they are continuous with those of adjoining calices, with which they unite, but yet are divided by the fine but distinct line before mentioned. When the septa are worn down, this line of depression is obliterated, and many of the united septa are very regularly geniculated. In a full-sized calice there are about thirty septa which are, generally speaking, of nearly the same thickness and length. Those, however, which have pali before them are a little stouter than the others. The pali are of nearly equal thickness and length with the septa, and in a calice having thirty septa there are fourteen pali, that is to say, nearly each alternate septum has one before it.

The columella is small and deeply seated. It is styliform, though a little compressed, and it is united in some of the calices to one of the pali. Both septa and pali are regularly denticulated, and the greater diameter of the denticulations is across the septum. This is most distinctly observable towards the ends of the branches, where the calices are circular and much more prominent.

When the septa are worn smooth and the lines of junction with those of contiguous calices are obliterated, this Coral has much the aspect of a *Thamnastræa*. Gemmation appears to take place in the interval between the calices, where smaller calices are observable. There is so much similarity between the septa of this species that I am wholly unable to trace the cycles. The cycles of the pali for the same reason are equally difficult of determination. The appearance presented is that of a calice with fourteen principal septa, and their pali. The diameter of the calices is about one line.

Although the genus *Stephanocœnia* is placed in the *Eusmelinæ*, and for want of better information respecting the Oolitic species I have placed the present species in that family, I am by no means assured that it should not be included in the *Astræinæ*. That both septa

and pali are distinctly denticulated is obvious, and that, with the union of the columella with one of the pali, should that prove constant, indicates a distinct genus.

Of the walls or endotheca I possess no information, the whole of the inside being crystalline.

STEPHANOCŒNIA EXPANSA, sp. nov. (Plate X. Fig. 11.)

The corallum consists of a thin and somewhat rounded plate, the edges of which are very thin, turned up, and a little undulating, and there is on a part of it a second or superimposed plate which partly covers the original one. The under surface has the middle part most prominent, by which it appears to have been broadly attached. There is an epitheca with faint concentric wrinkles. The whole of the upper surface is furnished with calices which are much smaller and shallower than those of *Stephanocœnia dendroidea*. As in that species, they are lozenge-shaped, ovoid, or round, and the depression bounding them is small but distinct, but the septa are continuous with those of adjoining calices. There are from thirty to thirty-seven septa, of which twelve are a little more developed than the others, and have pali before them. Twelve others have the same length, but are a little less stout, and the remainder are about two-thirds of that length, and are much thinner. Both they and the pali are a little exsert, and have their margins denticulated. The fossula is small, but well-defined, and contains a slightly depressed but styliform columella, which is larger relatively than in the preceding species.

The endotheca has not been observed.

Gemmation takes place in the interval between the calices.

Only one specimen has yet been met with. It was taken from a coralliferous stratum at Cooper's Hill, near Gloucester, which holds precisely the same stratigraphical position as the one at Crickley Hill.

Diameter of the corallum, three inches; its height about three-quarters of an inch; diameter of the calices, a little less than a line.

MONTLIVALTIA PAINSWICKI, Duncan.

Many specimens of this species have now been taken from the Lower Coral bed at Crickley, Birdlip, the Horsepools, and in the Painswick valley, most of which are small in size, the largest not exceeding that of the type-specimen figured by Professor Duncan. As a species it may be distinguished by the tendency to have one or more of its sides flattened. The form of the calice varies a good deal. When one side only is flattened, it has a rudely-formed semicircular outline. It may be more or less triangular or quadrangular, or indeed polygonal, according to the number of flattened sides of the corallum. There is an indication only of flattening of one side in the specimen figured by Professor Duncan, which was for some time in my hands. The calice of that specimen is deeper than is usual, owing to the septa having been somewhat worn down.

In the Oolite marl this species attains to a greater size than it does in the Lower Coral-bed. Two examples from that horizon at Birdlip

Hill are attached, the one to a corallite of *Donacosmilia*, and the other to a shell. They are three times the size of the figured specimen.

Several specimens of this species obtained from the Inferior Oolite in the railway-cutting at Hook Norton, Oxfordshire, have been sent to me with other Oolite corals by Mr. Hudleston. In all of these the flattened side, though visible, is only a little indicated.

Milaschewitsch pointed out that *Oppelismilia gemmans*, Duncan, was nothing more than a *Montlivaltia* which had been subjected to that sort of interrupted growth to which he gave the name of rejuvenescence. This growth, Professor Duncan maintains, is only what was long ago called by MM. Milne Edwards and Haime, "bourrelets d'accroissement," or growth-rings. It is, however, at the present moment, quite unimportant under what name we speak of it, but it is very important that we should distinguish very clearly between it and calicular budding, which is wholly different. But after the recent remarks by Professor Duncan on the subject, I can only conclude that he still confounds the two processes. He now places in the subgenus *Oppelismilia* the so-called *Montlivaltia Holli*, the "*Montlivaltia turbata*, Milasch., and any forms which Mr. Tomes may have noticed with calicular budding." If the so-called *Oppelismilia gemmans* has calicular budding, then have we a very extensive list of species of *Oppelismilia*, and the much crowded and difficult genus *Montlivaltia* will be materially and unexpectedly relieved. A very large per-centage of Lower Lias Montlivaltiæ will have to be withdrawn from that genus, and amongst others *Montlivaltia rugosa*, *M. mucronata* and *M. Haimei*, while from the Oolitic Montlivaltiæ a goodly number must also be eliminated.

In like manner a considerable number of genera or subgenera will have to be created for such compound corals as have the same sort of growth as in the so-called *Oppelismilia*. For instance, I have now before me a specimen of *Cladophyllia Babeana*, some of the corallites of which exhibit gemmation, supposing it to be gemmation which takes place in the supposed *Montlivaltia Holli*, and if one species of the genus *Cladophyllia* is really subject to calicular budding, it must, by a similarity of argument to that applied by Prof. Duncan to *Montlivaltia*, be separated from the other species of *Cladophyllia*. But it is an error to suppose that calicular budding takes place in either case, and even had it been so, it would still have been inconsistent in the extreme to retain *Montlivaltia Holli* (which is distinctly affirmed to have calicular budding) in the genus *Montlivaltia*, while for another *Montlivaltia* a new genus (*Oppelismilia*) was formed, for no other reason than that it had calicular budding.

Montlivaltia concinna, Tomes.

Subsequently to the description of this species several specimens were obtained, and with the exception of a single example they were taken from the Pisolite. They confirm the specific characters already given. This species may now be regarded as being invariably attached by a somewhat expanded foot, and as having an undulating

calicular margin, which is sometimes partially everted as in the specimen originally described. The thickness of the septa near to and at the wall is observable in all the specimens I have seen, and is a distinctive character.[1] It occurs in the Pisolite at Crickley Hill, Leckhampton Hill, and at Huddiknoll near the Horsepools, and a single example has been taken from a sandy bed immediately above the Upper Lias sands at Dover's Hill near Chipping Campden.

MONTLIVALTIA DE LA BECHEI, MM. Milne Edw. and Haime.

I have collected specimens of this species from the well-known section of the Inferior Oolite at Frocester Hill, where it is confined to the upper layer of the compact stone marked C in Dr. Wright's section,[2] which immediately underlies the equivalent of the Pisolite. The stratigraphical position corresponds therefore with that of the allied species *Montlivaltia lens* at Crickley and Leckhampton Hills. It is by no means rare at Frocester, but is with difficulty extracted from the stone. I have also taken this species from an exposure of a few feet of Inferior Oolite in the road leading from Bath to Combe Down, at a place called Holloway, and by the kindness of Mr. George I have had the use of a number of small examples which had been collected at Dundry. By the list of Dorsetshire species it will be seen that it occurs in several places in that county.

MONTLIVALTIA CUPULIFORMIS.

A single example of this species was all I had seen in 1882, and no other one has been met with from the same locality. I have, however, been favoured by Mr. S. S. Buckman with several examples from the Inferior Oolite of Bradford Abbas. In the original specimen obtained by me from Crickley, the adherent base is as broad as is represented in the figure given by the original describers, but in those from Bradford Abbas the constriction near the foot is, generally speaking, much greater, and the upper part of the corallum much more globose. None of the specimens from Mr. Buckman are attached, the narrow foot having been fractured.

MONTLIVALTIA sp.

There is a very distinct layer about the middle of the Pisolite at Cleeve Hill, Cheltenham, containing large flat concretions. Some of these are much overgrown with Bryozoa and small sponges, and occasionally a very young and attached *Montlivaltia* may be observed. The species is not determinable, none of the examples yet examined having attained to any visible height, while the greater number of them have not even reached that period of growth when the inclosing wall first shows itself.

[1] I think it right to suggest the possibility of this and some other Montlivaltiæ having wavy and everted margins, being merely the peduncles of a compound genus. The abnormal septa of the present species, as well as the excessively numerous ones of the species from the Middle Lias of Charmouth which I have described under the name of *Montlivaltia foliacea*, may prove to be costal prolongations of the septa in progress of development preparatory to gemmation.

[2] Quart. Journ. Geol. Soc. vol. xvii. p. 9, 1860.

CYATHOPHYLLIA OOLITICA, Tomes.

Repeated and diligent search for this species has been rewarded by the acquisition of two additional specimens, one from the Crickley Coral-bed, and the other from the same horizon at Huddiknoll, near the Horsepools, Gloucester, where the bed is much broken up and in a mixed condition. In neither of these is the columella so large or so clearly made out as in the type-specimen.

Prof. Duncan takes great exception to my retaining the genus *Cyathophyllia*, and after quoting Reuss and Pourtales, and giving cogent reasons for merging it into *Antillia*, as a subgenus of *Circophyllia*, observes that the facies of the Oolitic species of *Cyathophyllia* is not that of *Antillia*, and further "that any one who had studied the simple *Fungida* would place the form in the neighbourhood of *Thecoseris*, E. de From., the uniting and numerous septa being strong characters amongst the group. One must demur, therefore, to the admission of this comparatively unexamined form into the genus *Antillia* (which has precedence of *Cyathophyllia*)." Certainly. And I do most decidedly demur to its being placed in *Antillia*, even with the approbation of Reuss and Pourtales, and fully intend to retain it in *Cyathophyllia*. Examples of *Cyathophyllia liassica* (the type species) and *Cyathophyllia Oolitica* are now before me, and in both I observe the same crowded and anastomozing septa. Their generic identity does not admit of any doubt, nor does any doubt exist in my mind as to the propriety of retaining *Cyathophyllia* as a genus.

THAMNOSMILIA, gen. nov.

In the Oolite Marl of Leckhampton Hill, and at no other place, so far as I at present know, is a branching coral which possesses some of the characters of *Rhabdophyllia*, with the addition of a well-developed and rugose epitheca. Although by no means rare there, all the specimens I have seen have been completely inclosed in matrix, and could only be obtained by the use of the chisel and graver on some of the softer blocks. I define the genus as follows:—

The corallum is bush-shaped, the corallites lessening in size very gradually. Branching occurs unfrequently, and the branches are thrown out at a considerable angle. The wall is thick, and the epitheca well developed and very rugose. The calices are deep, circular, and their margins are thin. The septa are numerous, anastomozing, and passing into the columella, which is large, rugged, and spongy.

THAMNOSMILIA ANNULATA, sp. nov. (Plate X. Figs. 7, 8, 9.)

The corallum is not of great size, the greatest diameter of a corallite being only half an inch, and it consists of a peduncular portion attached to a shell. Generally the corallites have a diameter of two or three lines. They are seldom straight, but very frequently considerably curved. The epitheca is very thick and wrinkled, and disposed in rings around the corallites; they are nearly equidistant from each other and of nearly equal size, and they are continued the whole height of the corallites. The calices are very deep, almost circular, and a little expanded just at the margin, which is thin. The septa

of the small corallites are not numerous, being about 21 or 24 in number, that is to say, there are three cycles. Of these the septa of numbers one and two pass up to the columella, and those of cycle number three often bend towards and become attached to the earlier ones. In the larger corallites there are a great many more septa, and the cycles cannot be traced owing to their anastomozing so much. In the calicular surface of the peduncle I have mentioned there are at least fifty septa, and the older ones unite with each other, mostly in pairs, quite close to the columella, into which when united they often pass, while the newer ones run into the older ones at points more or less remote from the columella, according to their age. I have not as yet met with a perfect calice, that is to say, one in which the septa have their margins uninjured, and I cannot therefore describe them with any degree of completeness, but so far as I can observe, there is no ornamentation of any kind on their sides.

The columella is rather large, rugged, and spongy; its upper surface having about ten or twelve papillæ. It is deeply seated in the calice, and has no convexity.

The height of the corallum has not been ascertained.

Genus ——— ?

I have met with some portions of a dendroid Coral at Crickley and at Cooper's Hill, near Cheltenham, which I have failed to place satisfactorily. Its ramifications closely resemble those of *Donacosmilia Wrighti*, and increase takes place by lateral gemmation near the calice, just as in that genus, and there is usually a constriction at the attachment of the new corallite to the old one. As in *Donacosmilia* there is a well-developed epitheca. But it differs essentially from that genus in having numerous and very thin septa which have their sides ornamented by rather numerous and well-defined vertical ridges, ending in prominent points on their upper margins. The earlier formed cycles meet in the centre of the visceral cavity, and there form a rugged columella, which has its upper surface toothed like the margins of the septa. Where the epitheca has been worn off, numerous dissepiments are exposed.

I am at present unable to refer this species to any known genus, and the specimens are too fragmentary to admit of the formation of a new one.

EXPLANATION OF PLATE X.

FIG. 1. *Platastræa endothecata*, sp. nov., the under surface of the corallum of a small specimen (natural size).
„ 2. „ „ a portion of a larger specimen (natural size) showing the form of the calices and the continuity of the septa.
„ 3. „ „ the upper margin of a septum, magnified four times to show the denticulations.
„ 4. „ „ a portion of the lateral surface of a septum, magnified five times to show the regular and arched dissepiments.
„ 5. *Placophyllia gracilis*, sp. nov., the corallum, natural size.
„ 6. „ „ a calice magnified four times.

FIG. 7. *Thamnosmilia annulata*, sp. nov., a portion of a corallum, natural size, showing the rugose epitheca.
„ 8. „ „ calice of the same specimen (natural size).
„ 9. „ „ some septa magnified 2½ times, showing their connection with the columella. In this and in the foregoing figure, the septa are dark in colour as in the original; the infilling of the loculi being white.
„ 10. *Stephanocœnia dendroidea*, sp. nov., three calices, magnified six times.
„ 11. „ *expansa*, sp. nov., a calice, magnified nearly 14 times.

In neither of the figures of *Stephanocœnia* are the denticulations of the septa shown.

(*To be continued in our next Number.*)

II.—NOTE ON THE RECENT VOLCANIC ERUPTION IN NEW ZEALAND.

Communicated by ROBERT ETHERIDGE, Jun., Esq.,
of the British Museum.

THE "Lake District" of the North Island is too well known to all students of volcanic phenomena, especially of that branch comprising hydrothermal action, to need a detailed description. It will be sufficient to say that it forms a belt, crossing the island from north-east to south-west, and forms a portion of the Middle and Upper Waikato Basins of Hochstetter. The district has been recently brought into prominent notice by the disastrous eruption of Mount Tarawera, very full accounts of which have appeared in New Zealand papers lately received. The eruption commenced in the early morning of Thursday, June 10th, but premonitory symptoms showed themselves a few days before in a tidal wave, three feet high, on Lake Tarawera, great uneasiness of the springs at Ohinemutu, and the reported appearance of smoke issuing from Ruapehu, the highest of the great trachytic cones at the extreme south-westerly end of the system. The belt of activity extends from Mount Tongariro at the one end to White Island, in the Bay of Plenty, at the other, a distance of about 150 miles. White Island has undergone considerable change from volcanic action during recent years, and Tongariro was last in eruption in July, 1871; whilst its snow-clad sister cone Ruapehu has never manifested volcanic action within the historic period until now. This wide zone in the centre of the North Island has, ever since the arrival of the Maoris, been the scene of such extraordinary phenomena, that it has of late been the resort of visitors from all quarters of the globe.

At 2·10 A.M. on June 10th the inhabitants of the rising town of Rotorua were aroused by a violent earthquake, accompanied by a fearful roar, whilst away to the south Mount Tarawera appeared to be in eruption, an immense black mushroom-shaped cloud hanging over the whole country from Taheke to Pairoa Mountain, accompanied by lightning and heavy peals of thunder. About 4 A.M. ash-dust began to fall, but a shift of wind turned it coastwards, "where it worked its calamitous will to the full." As the day wore on it was found that Rotorua had not suffered much beyond this covering of dust and the appearance of fresh boiling springs, neither

had the celebrated hot bath of Ohinemutu suffered. On the opposite side of Lake Rotorua, however, the mud-hole of Tikitere, noted for its violent spouting and smell, had broken out.

It appears from later accounts that this volcanic outbreak commenced at Ruawhia, one of the three peaks into which the cone-like Tarawera is split. This volcano stands on the southern shore of the lake of the same name, and is about 2000 feet high; but no tradition of its ever having been active before exists amongst the Maoris. Indeed, it had been used by them for centuries as a place of sepulchre, somewhat after the manner of the Parsees and their "Towers of Silence." At the early stage of the eruption it was found that three large craters had developed themselves on Mount Tarawera, whilst a fourth was afterwards ascertained to have opened on the flank towards Lake Rotomahana. From these were belched forth flames and large quantities of stones, ash-dust, and clouds of smoke, which passed over the country both in a northerly, north-easterly, and southerly direction.

It was, however, at the Township of Wairoa on Lake Tarawera, midway between Rotorua and Mount Tarawera, that the greatest devastation took place and injury to life and property. Violent earth tremors were experienced between 1 and 2 A.M., accompanied by showers of ash-dust, and followed by that of stones and volcanic mud, which ultimately buried the whole place to the depth of ten feet. The houses were demolished, both those of Europeans and Maoris, and many persons killed, including Mr. C. A. Hazzard, the resident schoolmaster, and members of his family. Had it not been for the great intrepidity of Mr. McRae, proprietor of the Rotomahana Hotel, which was also destroyed, a further loss of life would have doubtless taken place. The pretty Tikitapu bush between Wairoa and Rotorua was completely destroyed, and the ground covered to a depth of three feet with dust; trees of 170 feet in height uprooted, and forming in places tangled masses ten feet thick. All undergrowth was swept away by the accompanying storm, and vegetation destroyed. The waters of the Tikitapu and Rotokakahi Lakes, celebrated for their blue and green colours, were changed to a dirty brown tint, and the outlet of the latter to the larger lake Tarawera was blocked, and its course altered.

The explosions which took place during the eruption of Mount Tarawera were plainly heard in Auckland, 180 miles to the north, and also at Te Aroha. Earthquakes were experienced at Tauranga, Maketu, and Opotiki, on the shores of the Bay of Plenty, and dust showers took place at each. At Cambridge and Hamilton, north-west of the more acutely disturbed district, and between it and Auckland, reports of heavy explosions were heard, and the windows shaken; and much the same phenomena were observed at Coromandel. Even at such distant places as Dunedin and Christchurch, in the South Island, electrical disturbances were manifested, believed to be traceable to this volcanic outbreak.

On June 13th matters had calmed sufficiently to allow exploration and relief parties to proceed beyond Wairoa, and ascertain the con-

dition of the world-reputed Lake Rotomahana, and the fate of the Maori settlements on the southern arm of Lake Tarawera. The expeditions in question were conducted by Mr. James Stewart, Major Mair, Mr. G. M. Reed, Mr. McRae, the Warbrick Brothers, and Mr. H. Steele, with Dr. Hector, the Government Geologist, at great personal risk and after much acute suffering. The sum of their reports was, that Lake Okaro and Mount Kakarema, to the south of Rotomahana, were in their normal condition, but along the creek connecting the former with Lake Rotomahana four craters had broken out, as well as a large one, 400 yards long, on the flank of Mount Tarawera, overlooking Rotomahana, where all had before been fern and tussock grass, throwing up showers of stones, dust, and volcanic mud. Rotomahana itself appeared to be one immense cauldron, composed of a series of smaller craters in full action, of which eleven to fifteen were counted, belching out clouds of steam, stones and mud. The site of the Pink Terrace was occupied by one of the largest of these, but that of the White Terrace was "clean blown out of existence," and occupied by immense fumaroles. The dividing line between the mud eruption and the showers of dry dust over the surrounding country was remarkably well shown. From Rotomahana towards the south-west, the latter extended around Lake Okaro, and back to Lake Rerewhakaitu, covering an area of not less than seven square miles. Away to the northward, the whole of the north shore of Lake Rotorua "wore the grey drab tint of the volcanic *debris*." It now appears tolerably well proved that it was the mud from the volcanoes developed on the site of Lake Rotomahana that destroyed the ill-fated Wairoa township; as well as the Maori settlements of Te Ariki and Moura on Lake Tarawera, with all their inhabitants. This volcanic mud has covered a very large area, from fifteen to twenty miles in length, by an average breadth of ten or twelve miles. It extended from Rotomahana on the south to near Ohinemutu on the north, and along the shores of Lake Rotorua to Ta Heke. The depth varied from a few inches to ten feet, but at Te Ariki, near the point of ejection, it was estimated to be at least thirty feet in depth, and it was very heavy, which will account for the manner in which the houses at Wairoa were crushed down.

Dr. Hector, C.M.G., F.R.S., is stated to have expressed the opinion that the earthquake shocks caused by the outbreak of Mount Tarawera ruptured the steam pipes in the Rotomahana geysers, and let in the water of the lake upon the subterranean heat, resulting in the generation of enormous quantities of steam, and the ejectment of the mud at the bottom of the lake. The material thrown out by Mount Tarawera appears to have been more of the nature of a white earthy pumiceous dust, but so far as yet known lava has not been observed. The pumiceous dust was examined by Profs. Brown and Thomas, of Auckland University College, who report on a sample obtained at Tauranga, that it consisted of angular grains of quartz, volcanic glass and finely divided pumice, fragments of felspar, hornblende, and other volcanic minerals.

My colleague, Mr. Thomas Davies, F.G.S., of the Mineralogical Department, British Museum, has examined samples of the dust sent home by Mr. Henry Gray, of Auckland, and collected at Rotorua, and also at Tauranga, which is from forty to fifty miles from the points of eruption, and finds, the former, which is the coarser, consists of pumice, a glassy scoria, subangular quartz-grains, and a felspar which is probably orthoclase; the latter is of the same materials, but finer, and includes more pumiceous dust.

We cannot do better than close this brief account of the Tarawera eruption by quoting the statement of two of the explorers, Mr. H. Steel, and Mr. Blomfield, artist to the *New Zealand Herald*, who appear to have approached nearer to the points of eruption than any other explorers, up to the time our last advices left New Zealand.

"We reached a very high and steep hill, almost perpendicular, immediately above what once was Rotomahana Lake, but which is now an immense basin, studded with hundreds of small volcanic cones, geysers, fumaroles, and ngawhas, a regular witches' cauldron, awful and terrible . . . . . From the point at which our party was standing we enjoyed a good view of Tarawera Mountain, Rotomahana, and the line of volcanoes between Rotomahana and Okaro Lake. One of these was throwing up black mud to a great height. It was forming a high bank of mud on the western side of its crater. An immense body of steam was rolling out of a large circular hole, some two or three chains in diameter. Other volcanoes were throwing out what seemed like a mixture of steam and smoke, but no lava was proceeding from any of them. Low down on the Tarawera Mountain, across the lake, a crater was still smoking, and from its lower lip there was a large fissure, through which Rotomahana Lake had evidently burst into the volcano. By this means an immense amount of steam had doubtless been generated, and the explosion which blew the bottom and sides out of the lake, leaving it an almost dry basin, had followed. We observed several other craters on the Tarawera Mountain still smoking, and in the one opposite to us we noticed a large deposit of pure sulphur. . . . . The view obtainable from the top of the upper hill, the nearest point to which any one had penetrated, was always more or less obscured by the steam rising from the basin.

"From the top of the hill above mentioned the ground sloped almost perpendicularly, and Mr. Blomfield and myself went down the first half of the hill in grand style, without realizing the difference between going down and climbing back again. However, we had this brought forcibly to our minds very soon afterwards. We landed on a small terrace, and then the descent of another hill (not so steep) landed us on a small mud flat which lay between the foot of the hill we had come down and the edge of the crater—that is, of the place where Lake Rotomahana once was. We walked to within five feet of the edge of the abyss, and looked over, and saw a sight which I do not think either of us will ever forget. The wind blowing from the north lifted the steam and disclosed the dry bed of Rotomahana, which is now one scene of volcanic action, impos-

sible for words to describe. . . . . A few pools of dirty boiling water still existed at the western end, and a rather large one at the eastern end. Hundreds of volcanic cones were throwing out steam, and what appeared to be black smoke. Scores of geysers were playing away merrily, throwing water many feet into the air. In one place a small plateau of mud had been thrown up, and on it was a pool of yellow boiling water, from one end of which a jet of dirty smoke or steam as thick as a man's body was issuing. About one hundred yards from the western end a large volcano, in very violent action, kept up a continual discharge of mud and steam, accompanied by a heavy rumbling, roaring sound. It would be impossible to describe the wonders of the scene in their infinite variety of volcanic grandeur. We were then standing on the bank above where the Pink Terraces formerly existed. The whole southern bank of the lake has been blown completely away, and the spot where the Terraces once stood is now an open gap. We next walked round the crater to the western end of the lake, to try to obtain a view of the White Terraces. Having waited till the steam lifted, we then saw that the White Terraces were also gone. The appearance of the place where they had stood was entirely changed, but a very active geyser was still playing. Returning back to where we first came down to the crater's edge, Mr. Blomfield took a sketch of the scene before us. We then started on the return climb—a very different thing from the descent. After a long pull, we got on to the first terrace, and then began the ascent of the big hill. We slowly crawled up its steep face, digging our hands and knees into the soft mud of which it was composed. . . . . We stopped to rest every few minutes, preventing ourselves from slipping back by thrusting our arms straight into the face of the hill, but when we got within thirty feet of the top, a slight earthquake shock, which shook the hill and sent the sand down round us, acted like a refresher, and we made good time to the top, where we found the rest of the party."

It is also reported that Tarawera had developed seven craters on the Tarawera Peak proper, and three on Ruawahie. It is further believed that those on the immediate site of Rotomahana will remain permanent.

III.—The Unconformity between the Bagshot Beds and the London Clay.

By the Rev. A. Irving, B.Sc., B.A., F.G.S., of Wellington College.

In the paper on the well-section at Brookwood in the August Number of the Geological Magazine,[1] the author pointed out that a comparison of the lithological facts brought to light in that section with those furnished by two other deep-well sections (at Wokingham and Aldershot respectively) lead to an inference in favour of a considerable amount of denudation of the London Clay having taken place during the deposition of the Bagshot Beds; that is to

[1] While that paper was passing through the press, the author was informed by the contractor, Mr. S. P. Coaker, that "a very perfect shark's tooth was found at the depth of about sixty feet." May not this have been derived from the London Clay?

say, irrespectively of the particular horizon in the Bagshot Series to which certain marginal portions of the Bagshot Beds may be ultimately assigned, there seemed to be pretty clear evidence furnished, from the London Clay itself, of the fact, that along their northern and southern flanks the *Bagshot Beds rest on beds belonging to lower horizons in the London Clay formation* than those on which the Bagshot Beds rest in the more central portions of the area. The present brief paper is an attempt to show that the above conclusion is borne out by a much wider induction from data gathered from the area of the London Basin in general. I have carefully gone through the 448 well-sections appended to Mr. Whitaker's Memoir on the London Basin,[1] and have selected from among them such instances as seemed to throw any light upon this question. A large majority of those sections include the London Clay; but since, in a great number of them, the thickness of that formation in feet is given only, unaccompanied by any lithological notes on the strata, they have been omitted, as affording no help to us in the present investigation. There are, however, as many as 29 sections, in which such notes appear. In every one of these the Reading Beds or the Thanet Sands, and in most cases both these formations, were proved below the London Clay, so that we are quite sure of a *correct basal horizon*. In many instances also the Basement Bed of the London Clay is noted. In 22 of these 29 sections, the thickness of the London Clay is less than 200 feet, and in all these there is mention of such inclusions in the strata as 'green sand,' septaria ('clay-stones'), pyrites, flint pebbles, and 'shells.' These therefore agree in this respect (without a single exception) with the lower half or rather more of the London Clay of the Brookwood section, as shown in the deep well at the Asylum on Knap Hill, which also (as shown in my last paper) agrees with the London Clay strata pierced at Wokingham on the northern, and at Aldershot on the southern, margin of the Bagshot area. From this I conclude that in all these 22 sections we have (within their several limits) homotaxial equivalents of strata of the lower half or rather more of the London Clay, as that formation is proved in the Brookwood section.

In the remaining seven sections there is no mention of septaria, etc., above about 200 feet from the base of the London Clay. Of course this does not absolutely prove the absence of them, in these seven sections, but the number of instances is sufficiently large to establish a high degree of probability that they were not found at those higher horizons; and in every case there is mention of them at horizons below. The list from which this inference is drawn includes sections at Aldershot Place, on the south side of the area, at Hampstead, Harrow, Braintree and Chelmsford, on the north, and at Canterbury in the extreme east. The great majority however are in the metropolitan portion of the area. One of these (at Wimbledon) corresponds so well with the Brookwood section,[2] that it deserves to be given here more in detail, as follows:—

[1] Memoirs of the Geol. Survey of Great Britain, vol. iv.
[2] Geol. Mag. August, 1886.

		feet.	
	Soil and clay (brown)	3	
			3
London Clay.	Lead-coloured, hard, flaky clay	20	
	Reddish sand and lead-coloured clay	80	
	Lead-coloured, strong loam	60	
	Lead-coloured clay or loam, with stony nodules (septaria)	40	
	Hard rock	½	
	Lead-coloured clay with much sulphur, many lumps of stone, giving off "noxious air," some rotten wood below	236	
	Hard rock	½	
	Total thickness of London Clay		437
			440 ft.

This well was "sunk all the way."

At page 282 of the Memoir, Mr. Whitaker mentions a section in the Wimbledon neighbourhood, which shows a passage upwards from the London Clay into Bagshot Sands. This bears out the inference which I drew in my last paper from lithological evidence very similar to that cited by him, as to such a passage occurring in the well-section at Brookwood.

It is of course a rare thing in wells in these Tertiary strata to come across a shoal of fossils, such as that mentioned by me[1] elsewhere, as occurring in the green earthy sand of the Middle Bagshots at Yateley, Hants; but isolated fossils are occasionally met with, and generally, as might be expected, in a good state of preservation in the London Clay. In the deep well at the Ascot Racecourse, of which I have already published an account,[2] the following, which are now in my possession, were found: *Pholodomya margaritacea* (192 above the base); *Cyprina planata* (a rather young individual). A well-rounded pebble of flint was also found at 75 feet above the base of the London Clay.

Prof. T. Rupert Jones, F.R.S.,[3] has also mentioned the following as met with in the Wokingham deep well: *Cardium, Cyprina planata, Pholodomya virgulosa, Nautilus, Panopæa intermedia, Pinna* (fragment), *Dentalium, Actæon, Natica, Astarte, Cytherea tenuissima, Ditrupa.* These forms range through the whole of the 273 feet of the London Clay pierced in that section, including the Basement Bed.

From Mr. Phillips's brick-yard, close by Wokingham Station, and a few feet only below the unconformable junction of the Bagshot Sands and the London Clay, which is seen just below St. Paul's Church,[4] I have obtained the following forms: *Cypræa Bowerbankii, Cardium Laytoni, Corbula Regulbiensis* (?), *Modiola elegans, Panopæa* (fragment), *Pleurotoma gentilis, Vermicularia Bognoriensis.* Some of the septaria found in this pit are charnel-houses of scarcely any other forms than *V. Bognoriensis.* The presence of these forms would seem again to indicate a tolerably low horizon in the London Clay for the beds on which the Bagshot Sands at Wokingham are superimposed. Oxidation-products of pyrites and flint pebbles are common in the London Clay here.

[1] Q.J.G.S. August, 1885, p. 500. [2] Proc. Geol. Assoc. vol. ix. No. 5.
[3] Geol. Mag. Decade II. Vol. VII. pp. 422, 423.
[4] Q.J.G.S. *loc. cit.* p. 505, fig. 4.

From the London Clay at Aldershot, in the brick-yard due south of the Station, I have obtained *Cypræa Bowerbankii*, *Modiola elegans*. The last-mentioned is very abundant in the septaria of that locality.

In his excellent work, *Stratigraphical Geology and Palæontology*,[1] Mr. Etheridge remarks: "Prof. Prestwich has shown that there are traces of palæontological zones in the London Clay, the lowest indicating in the east of the area of deposit a maximum depth of water (500 feet), while a progressive shallowing is seen in the higher zones, the uppermost of which contains the chief part of a terrestrial flora, as well as the fish and reptilian remains, all of which are seen in the Sheppey Beds."

The thicknesses given by Prof. Prestwich[2] for the London Clay, as proved in two wells at Sheerness, are 347 feet and 356 feet, very near approximations to the least thickness (371 feet) assigned in my last paper to the same formation in the Brookwood section. There too, according to Mr. Whitaker,[3] "the London Clay has a more loamy character and brown colour; there are also some beds of sand (north of Wyburns) which become more numerous further east, so that *there is no sharp line of demarcation between the undoubted London Clay and the overlying sand, which has been referred to the Bagshot Series.*" This corresponds very well with what I have described as indicating a passage in the Brookwood section; while such features are conspicuous by their absence in all sections where I have seen the Bagshots resting on the London Clay along the flanks of the present Bagshot area.

It is much to be regretted that the works at Brookwood were not watched during the progress of the well through the London Clay. As it is, there would appear to be no record of any traces of a 'terrestrial flora' or of 'fish and reptilian remains' to correspond with those of the Sheppey Beds. In the most complete as to its details of the well-sections referred to in this paper — that of the Wokingham Town Well—furnished on so excellent an authority as that of Prof. T. Rupert Jones, there is no mention whatever of any traces of those remains which seem to characterize the higher zones of the London Clay; nor have I met with any in the brickyards at the surface. It would appear, therefore, that at Wokingham the evidence furnished by the London Clay itself, as to the removal by denudation of all the upper portions of that formation, before the Bagshot Sands were deposited upon it, is pretty direct and conclusive; and this entirely harmonizes with the observations, which I have previously recorded,[4] of the evidence of erosion of the London Clay beneath the Bagshot Sands at Wokingham, and the occurrence of rounded flint pebbles on that eroded surface at the bottom of the Bagshot Sands there exposed.

Taking all the facts adduced in this paper, and comparing them with those mentioned in my paper on the Brookwood section, it is

[1] Page 610.
[2] Q. J. G. S. vol. x. p. 404, quoted by Mr. Whitaker at p. 469 of the Memoir on the London Basin.
[3] Memoir, p. 317.
[4] Q. J. G. S. August, 1885, pp. 504, 505; Proc. Geol. Association, vol. ix. p. 222.

difficult to see how we can arrive at any other conclusion than one favourable to unconformity, *from evidence furnished by the London Clay itself.*

Where this formation exists in its full normal development, with Bagshot Beds superimposed upon it, there appear to be clear signs of a passage from one formation into the other: on the other hand, where—as in sections elsewhere described by me—on the marginal portions of the Bagshot area, the transition is an abrupt one, the stratigraphical data furnished by the London Clay seem to lead to the necessary inference, that the upper beds of that formation, to the extent of probably 100 to 150 feet in thickness, were removed by denuding agencies (furnishing perhaps the clayey materials of the Middle Bagshots[1]) before the Bagshot Beds were deposited upon the London Clay in those localities.

Note.—In generalizing from a number of deep well-sections in a given geological district, it would be mere pedantry to insist upon the exact value of the measurements in every case. Errors may arise from tubes getting out of the vertical, and from the materials getting mixed up to some extent in the boring tools. But they no more vitiate the conclusions drawn from a general agreement of a number of sections than those slight variations allowed for on the score of "errors of experiment" in experimental science invalidate the conclusions drawn from a general agreement of results. In some instances, moreover, we have more definite data than a mere boring can furnish. At Brookwood, for example, the six-foot well with iron-cylinders was carried down to a depth of 197 feet, that is to say, through the whole of the Bagshot series and into the London Clay; at Wellington College the six-foot well penetrates about 180 feet; in the Ascot deep-well mentioned above the shaft or well extends down to 250 feet; and in the deep well at Wokingham the six-foot "dry-sinking" was carried down to 264 feet, that is, into the Basement-bed of the London Clay.

IV.—Notes on the Discovery of the base of a Large Fossil Tree at Clayton.

By S. A. Adamson, F.G.S.

ONLY a short time since there was discovered in the Lower Coal-measures at Idle, a magnificent specimen of *Megalichthys Hibberti;* and now, at Clayton, near Bradford, has been found one of the grandest examples yet seen of a fossil *Sigillaria* tree. It was in the Fall Top Quarry, at Clayton, worked by Messrs. Murgatroyd and Sons, that this remarkable fossil was discovered, and these gentlemen deserve the highest praise from all geologists for the skill and extreme care with which they have bared the fossil, and also for their kindness in allowing it to be inspected. This quarry is not far from the edge of a bold escarpment overlooking the Thornton Valley, and the well-known Elland Flagstone is worked here for landings, flags, etc. Between the Better-Bed-Coal and the Flagstone

[1] Cf. Proc. Geol. Association, vol. ix. No. 5.

there is a great thickness of sandstones, shales, etc., of various characters, and it was in these measures that the fossil tree was discovered about 12 feet below the surface. The sandstones just referred to are of little commercial value, many being irregularly bedded, and others very perishable in their nature; the better kinds are used for rough walling, the remainder being merely rubbish to fill up other excavations. The marketable flagstone is at a considerable depth in this quarry, and blasting operations have to be carried on to remove rapidly the overlying strata. After one of these explosions, Messrs. Murgatroyd observed part of a large fossil tree exposed, and, profiting by their knowledge of geology (which, by the work of the Yorkshire Geological Society and also of the Leeds Geological Association, is rapidly spreading throughout the entire county), they immediately suspended further operations, and, instead, gave orders to their workmen to carefully bare the remainder of the roots. Part of the stump and four of the roots were damaged by the explosion, but four roots were left *in situ*. Since then, the broken pieces have been collected and placed together most admirably, presenting now the remarkable sight of a huge stump of Sigillaria, sending out eight forked stigmarian roots. The following dimensions, carefully measured, will afford an idea of the magnitude of this fossil :—

	ft.	in.
Height of stump	3	9
Diameter of stump (longest axis)	4	6
,, ,, (at right angles to longest axis)... ...	3	10

Root.	Diameter close to stump.	Distance from stump to bifurcation of roots.	Distance from point of bifurcation to present termination of root. Right fork.	Left fork.	Greatest length of root.
No.	inches.	ft. in.	ft. in.	ft. in.	ft. in.
1	21	4 0	9 6	13 0	17 0
2	17½	4 0	8 0	6 6	12 0
3	16	5 0	7 0	4 0	12 0
4	16	4 0	2 0	4 6	8 6
5	17½	7 0	1 6	3 0	10 0
6	18	5 6	3 0	4 6	10 0
7	17	7 6	3 0	2 0	10 6
8	17	7 0	9 6	7 0	16 6

The diameter of the visible area covered by the ramifications of the roots, is, from north to south, 29 ft. 6 in. and from east to west 28 ft., giving a superficial area exposed of 826 feet. The stump of the tree was embedded in soft sandy shale, locally termed "yellow loam," the roots resting on a bed of soft blue shale, which some of them penetrate. The roots 7 and 8, and also the roots 1 and 2, respectively cross each other, producing depressions in the lower roots at the point of contact. The Stigmarian roots present very finely the characteristic pits or scars from which the rootlets or filaments formerly originated, and an examination of the shale immediately touching the roots, reveals these rootlets in vast numbers. The neighbourhood appears to be prolific in grand examples of Carboniferous vegetation, for in another part of the quarry at a short distance, I observed two large stigmaria protruding from the side, whilst in the

cutting of the railway close by, a good, but much smaller specimen of Sigillaria, with roots attached, was carefully got out, and presented by the engineer to the Yorkshire College at Leeds. So remarkable a fossil as the one described should be procured at once for one of our museums; it would be an unrivalled example for geological students. To allow it to meet the common fate of many fine fossils, that of being broken up for rockeries or gardens, would be an act of inexcusable and gross scientific vandalism. The proprietors intend, although it stops the progress of their business, to allow it to remain undisturbed for three or four weeks longer, and to any geologists tempted by the breezy Yorkshire hills and fine scenery, they offer a hearty Yorkshire invitation to inspect this giant fossil.

NOTICES OF MEMOIRS.

I.—Short Notices of Scientific Papers.

1.—Bibliothèque Géologique de la Russie, rédigée par S. Nikitin. Large 8vo. pp. 126. (St. Petersburg, 1886, Librairie Eggers et Cie.)

THIS work is intended to be a record of all books, periodical publications, and brochures treating of the geology, mineralogy, and palæontology of Russia, whether published in that country or elsewhere. It gives a short *résumé* of the contents of each work in Russian and French. The present is the first memoir of the series, and contains references to 256 separate papers which have been published in 1885. They appear to have been very carefully prepared, and in the palæontological papers the names of the new genera and species are quoted. There is also a complete index. This record will be of special value to all geologists, to whom at present works published in Russian are quite unavailable, for it will at least furnish an idea of the progress of the science in that country, and we sincerely hope that it may be continued in future years.

Annalen des K. K. Naturhistorischen Hofmuseums; redigirt von Dr. Franz Ritter von Hauer. Bd. i. No. 2. (Wien, 1886.)

This second number of the Annals of the new Natural History Museum at Vienna contains amongst others, the following important papers:—

2.—Ueber die miocenen Pteropoden von Œsterreich Ungarn, von Ernst Kittl. Mit einer lithogr. Tafel.

The characters of the minute and delicate shells of Pteropods from the Austro-Hungarian Miocene strata are carefully worked out, and illustrations given of most of the species. Their presence in great numbers indicates, according to the author, the abyssal character of the deposit. The following new species are described: *Creseis Fuchsi, Vaginella Lapugyensis, V. austriaca, V. Rzehaki, Balantium Fallauxi, B. Bittneri, Hyalæa bisulcata, Spirialis Kœneni, S. Tarchanensis,* and *S. Andrussowi.*

3.—Ansichten ueber die palæozoischen Insecten, und deren Deutung; von Prof. Dr. Friedrich Brauer. Mit zwei photozinkogr. Tafeln.

This is an elaborate critical review of the classifications adopted by Scudder, Brongniart, and others, for Palæozoic insects, and of the significance of the characters on which these have been based. In many points the author disputes the views of Scudder, lately published in Zittel's Handbuch der Palæontologie. The wing-structures of many of the Palæozoic insects and of their nearest living allies are well illustrated in the accompanying plates. Amongst other conclusions, the author states that the Palæozoic insects present no contradiction to the views of biologists as to the origin of the class, and that they did not form a special order which could be regarded as a general basis for the existing orders of insects.

4.—Bestimmung des specifischen Gewichtes von Mineralien, von Dr. Victor Goldschmidt.

The author points out the causes for the differences occurring in the practical determination of the specific gravity of the same mineral; which rest not so much in the method adopted as in the selection of the materials which are tested. G. J. H.

II.—Nouvelles Observations sur des Traces d'Animaux et autres Phénomènes d'origine purement mécanique décrits comme "Algues Fossiles." Par A. G. Nathorst. Avec 5 planches en phototypie et plusieurs figures intercalées dans le texte. Kongl. Svenska Vetenskaps-Akademiens Handlingar, Bandet 21, No. 14. (Stockholm, 1886.)

THIS memoir is intended as a reply to the objections raised by the Marquis of Saporta and MM. Lebesconte and Delgado, to the opinions previously published by the author, that many of the supposed fossil algæ are in reality nothing more than the tracks of animals, or phenomena of purely mechanical origin. The fossils, whose nature is thus contested, are commonly known as *Cruziana*, or *Bilobites*, *Harlania*, *Eophyton*, and some other genera. They generally present themselves in demi-relief on the *under* surface of the beds in which they occur; no traces of organic substances are found associated with them, and they are composed of the same minerals as the matrix in which they are imbedded. The theory of their vegetable character rests on the peculiarity of their markings, which are supposed to be incapable of being produced by the tracks of organisms. Dr. Nathorst, however, shows very conclusively, that whilst it is difficult to understand how algæ could thus form casts in demi-relief on the under surface of the beds, such structures would be the natural result of the filled-up tracks or burrows of marine organisms. Of the *manner* in which these could be made, the author gives practical proof by passing a movable roller, shaped like a double spindle, over the surface of a layer of soft mud, and then by means of gypsum obtaining moulds of the concave impressions. Photographs of these moulds are given in the accompanying plates, and they faithfully represent in almost every detail, the supposed

algæ. The author by no means denies the probable occurrence of true Algæ in Palæozoic strata, though he considers that most of the forms described as such by Saporta have no claim to be included in the vegetable kingdom. G. J. H.

III.—On the Flora of the Cromer Forest-Bed. By Clement Reid, F.G.S. Transactions of the Norfolk and Norwich Naturalists' Society, vol. iv. pp. 189—200.

FROM various exposures of the so-called Cromer Forest-Bed at different localities on the coast of Norfolk, and at Pakefield in Suffolk, Mr. Reid procured samples of dark peaty sandy clays, which by careful manipulation and washing, yielded the seeds and fruits of a number of plants. These were patiently and carefully picked out under a magnifying glass, classified, mounted, and then compared with existing forms, with the results that the number of species in the accompanying list is more than double that previously known. The species of Mosses and *Chara* have not yet been determined, but the list includes 40 species of *Dicotyledons*, 18 of *Monocotyledons*, 5 *Gymnosperms*, and 3 *Cryptogams*. With a few exceptions the same plants still exist in the locality, but some are locally extinct. Mr. Reid points out the significance of this fact, when it is considered that since the period when the plants lived whose fruits and seeds have been preserved, the Glacial epoch has intervened, and the large mammals, and even many of the mollusca, have become extinct. So far the investigations into the Pliocene Flora show that the period of intense cold produced but little effect in the distribution of the plants in this locality, since the same forms with few exceptions returned, apparently without intermixture, to re-occupy their former habitats.

The paper is a brief one, but it represents a great amount of steady, continuous work, and careful observation. It will prove of much value, both from a botanical as well as a geological point of view, and its importance is enhanced from the fact, that with one or two unimportant exceptions, no Plant-remains are yet known from other Pliocene beds in Britain. G. J. H.

REVIEWS.

I.—Department of the Interior. Report of the United States Geological Survey of the Territories. F. V. Hayden, United States Geologist-in-Charge. Volume III. The Vertebrata of the Tertiary Formations of the West. Book I. By Edward D. Cope, Member of the National Academy of Sciences. (Washington, Government Printing Office, 1883.)

IN recent scientific history of civilization few administrative events can compare in magnitude, or in their effects upon the populations concerned, with the Geological Survey of the United States. In no other part of the world have the resources of the Government been used with a like wisdom and liberality in accumulating and diffusing natural knowledge of the country, for

the benefit of the people. It is impossible to express too strongly admiration for the administrative discernment which has recognized that organized knowledge of the geographical, geological, botanical, zoological, and anthropological conditions of the newly-settled lands of the West, is the necessary foundation for their commercial, social, and political prosperity. But when we contemplate the library in which the achievements of this great conception stand recorded, with all the elaboration which the best science of our time could command, we yield homage to those who have planned and have carried out this work, for a service to their country and to humanity, which in its way has no parallel.

The branches of science are so interrelated, that none can be said to be less or more important than the others. And if to the popular imagination geology and palæontology do not seem quite so engrossing as other matters among life's interest which develope from them, as a foundation, it is manifest that they have engaged the enthusiasm and life-long labour of intellects among the most remarkable which modern times have produced. And the great American Republic may be congratulated on having commanded the services of men of genius, whose courage and industry have been equal to grappling with this gigantic work.

The latest of the United Survey Reports, by Professor Cope, issued as a first part of a brief history of the fossil remains of Vertebrata, found in the Tertiary rocks of the Western Territories, extends to more than a thousand quarto pages of text, illustrated with some woodcuts and one hundred and thirty-four quarto plates, and gives in a noble and connected form a panorama of the life which the author had studied during the preceding ten years. Professor Cope's previous contributions to the same series of publications have prepared us for these matured studies, which are well described by Major Powell, the Director of the United States Geological Survey, as a "valuable contribution to palæontology, and a monument to the labour and genius of the author."

Professor Cope is a naturalist in the largest sense of the term; not undervaluing the great results which reward the comparative anatomist, but conspicuous among those who have cherished the traditions of zoologists, he has known well how higher results depend upon detailed work, and clear, full, and accurate description of the variable elements in organic structures. No man has a keener appreciation of the order of nature; and it is manifested again and again in new grouping, or the definition of new groups, or the intercalation of new types in their places among well-known tribes,—a power which is rare, because it can only flow from a knowledge of the extent to which the structures of any extinct type may vary, consistently with the preservation of its group plan, or the elimination from that plan of a series of characteristics. The gifts and attainments in which the analytical and synthetic powers are evenly balanced, and by which the extinct and existing life have been examined by the same methods, have long made the author of this work conspicuous as one of the most successful palæontologists who have yet adorned the science.

The volume now noticed is conceived in a systematic spirit. After the preface, which accounts for the origin of the collections, states the rules of nomenclature, and the chief scientific results attained, an Introduction describes the geological succession of Tertiary rocks of Western America, and attempts to correlate, on the evidence of their fossils, the American rocks which contain vertebrata, with those of Europe. If we do not discuss this correlation, it is because it raises questions which would require a volume for their examination; but we may say that just as the occurrence of fossil reptiles in America nearly allied to those in some European strata seems to us insufficient to fix the age of the American deposits; so the presence in American strata of extinct species of European genera of Mammals, even when many occur in common, is but uncertain proof of identity in age between the subdivisions of the American Tertiaries and the subdivisions recognized in Western Europe. But if this problem, which is taken up as it were by the way, is not finally solved, facts enough are presented to challenge attention, and justify the correlations which are made.

The first part of the volume discusses the Puerco, Wasatch, and Bridger groups of American fossil vertebrate life. The oldest of these is regarded as Tertiary, rather than as Post-Cretaceous. It is a lower division of the Wasatch series, with a distinct fauna, accumulated in the Wasatch Lake. The Wasatch beds range from New Mexico through Colorado and Wyoming, and consist of sandstones and marls, which vary from fifteen hundred feet to five thousand in thickness. Very few vertebrate fossils are found in the overlying Green River beds; but the Bridger group which succeeds has yielded a rich fauna, though the beds are less widely distributed than the older Eocene series.

The fauna of these beds comprises first, a large number of Fishes, which are observed to have a facies similar to that of the existing fresh waters of the United States, with the addition of two families now confined to the southern hemisphere. Among the Fishes we note a new Elasmobranch genus, *Xiphotrygon*, which is the genus *Trygon* with the teeth of *Raja*. The Lepidosteus type is represented by the extinct genus *Clastes*, of which four species are indicated. *Pappichthys*, another genus of these beds, differs from the existing *Amia* in having one, instead of several rows of teeth on the bones about the mouth, but though founded on mandibles, some of the species are described from vertebræ. The genus *Rhineastes* is a type of doubtful affinity, characterized by possessing vomerine teeth, and well known from five species. *Dapedoglossus* is a genus with four species closely related to *Osteoglossum*. *Diplomystus* comprises five species of Herrings, which differ from the genus *Clupea* in possessing small dorsal scutes in the median line of the back. The Perch type is represented by several genera, defined by the author under the names *Erismatopterus*, *Amphiplaga*, *Asineops*, *Mioplosus* and *Priscacara*. Of these genera, perhaps the most interesting is *Mioplosus*, which is allied to *Lebrax* and *Perca*. This fish fauna has more than ordinary interest from its occurrence in beds which

yielded the higher vertebrata. Of Batrachia, the only Tertiary specimen known is from the Green River beds, and belongs to a tailless Batrachian, but too imperfect for description.

The Reptilia of American Eocene age are in no way remarkable except for the appearance of new genera. The Crocodilia differ in no important character from existing species of the genus *Crocodilus*. Five species are found in the Wasatch beds, and six other species in the Bridger beds. Seven species are here described: one, *C. heterodon*, is as small as an Iguana, while *C. clavis* is equal to the largest East Indian species. The Testudinata are more numerous. Sixteen species are found in the Wasatch beds and thirty-two in the Bridger beds. *Emys*, *Trionyx* and *Plastomenus* are genera surviving from the Cretaceous period, while six new genera appear, of which five are limited to these deposits. The new genera include *Axestus*, which belongs to the Trionychidæ, *Anostira* of Leidy, *Hadrianus*, *Notomorpha*. The genus *Emys* is represented by eleven species. The Lacertilia are known from three species of *Champsosaurus*, especially interesting as a type which survives from the Cretaceous Laramie formation. Only one Serpent is known; it is referred to an extinct genus *Protagras*. After the remarkable reptile fauna of the Laramie and Cretaceous rocks, this reptile fauna may seem tame; but any one who studies the beautiful plates which illustrate it will find abundant materials for philosophic study among the narrow-nosed Crocodilia, the variously-modified Tortoises, and the vertebræ of *Champsosaurus*.

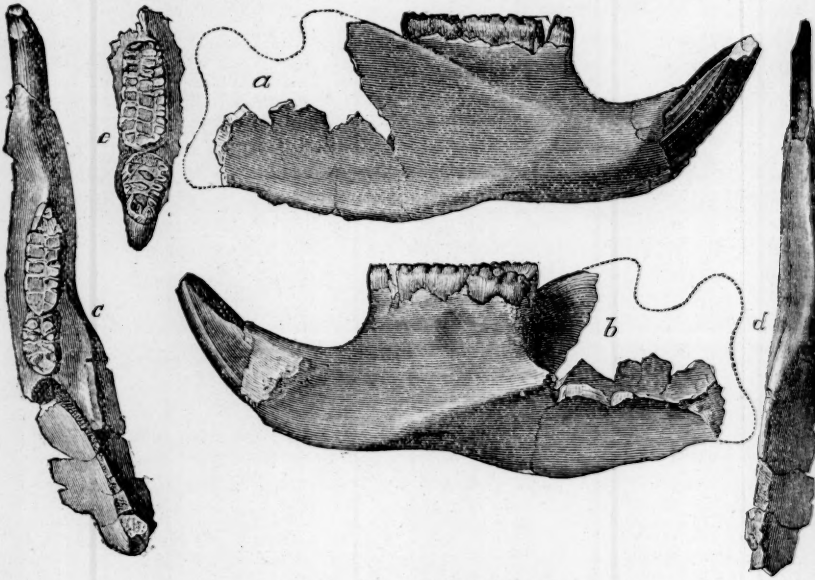
Turning to the Mammals, Professor Cope reminds us that the Mammalia, like the Reptiles of the Permian epoch, have the family types in the Eocene rocks of America all more generalized, and that the orders are not so sharply differentiated from each other as in the later periods of the earth's history. The contribution therefrom which America now furnishes to our knowledge of the Mammalia is one of the most interesting chapters in the history of the group.

The story begins with the Marsupialia. This is one of the most difficult groups to define accurately on account of the strong insectivorous strain of characteristics which is so often present among fossils. But among genera which are more definite in their affinities is the remarkable genus *Catopsalis*, a rodent-like type with the jaw inflected as in the Kangaroo and Kangaroo Rat, but with a tuberculated Mastodon-like molar dentition. *Ptilodus* is another interesting Marsupial, remarkable as representing the Purbeck *Plagiaulax* in the American Eocene, though the affinity is not of a distant kind.

Passing to the Rodentia, the representatives are again few. They are apparently allied to the Squirrels, and are referred to five species of the genus *Plesiarctomys*, a well-known type in the Eocene of France.

The next order is termed Bunotheria. It is defined as having the animals armed with claws, with a transverse mandibular condyle, the molar teeth usually tubercular, and with incisors in the premaxillary bone. There are usually five digits, and commonly a third trochanter to the femur. It comprises all those animals which the author had

at various times referred to the groups Creodonta, Mesodonta, Insectivora, Tillodonta and Tæniodonta, tribes which are now regarded as suborders of the Bunotheria. The group is almost as varied as the Marsupialia, and is regarded as a generalized type in which the relationships are not all with the smooth-brained mammalian orders,



Catopsalis pollux.

a Right ramus external.

b Right ramus internal.

c Superior view.

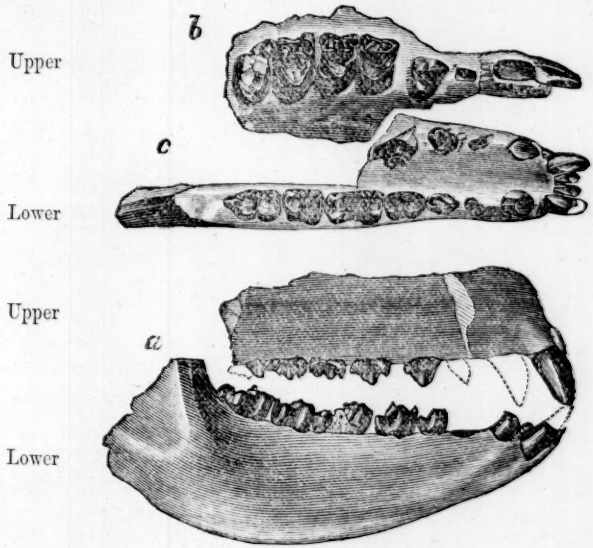
d Inferior view.

e *Polymastodon taoensis*, possibly molar teeth of *Catopsalis*.

Ptilodus mediævus.

but quite as close with the Gyrencephala. The Creodonta are thought to be the ancestors of Carnivora, while the Mesodonta are probably ancestors of the Prosimiæ, and the affinity between the Prosimiæ and the Carnivora is considered as established. The Tæniodonta have Rodent-like inferior incisors, but also possess inferior canines. Each molar has a simple conical fang, and the enamel

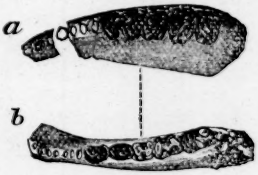
round it combines to suggest the characters of an Edentate. So that *Calamodon* is thought to furnish a hint of the relationship of the Edentata to other Mammals. *Tæniolabis* is a genus of allied character, founded on a single tooth. The Tillodonta is a suborder with rodent-like incisor teeth; and this character distinguishes the group from the Insectivora, to which the molar teeth approximate. There are three genera in this suborder. *Psittacotherium* has six inferior molars with cross crests, which with wear assume the form of the letter B, with the convexities turned forward. The incisor teeth are powerful and adapted for breaking nuts or cutting fruits. Two species are known. The other genera of this group have no representatives in the Wasatch and Bridger faunas. The Insectivora, which alone survive at the present day of all the Bunotheria, are well represented by the genera *Conorycthes* and *Esthonyx*. *Esthonyx* approximates to the Tillodonta in having the enamel of the incisors restricted in the lower jaw to the front of the tooth. The lower molars closely resemble those of the Hedgehogs, but several affinities are seen with Lemurs like *Chiromys*, and with the genus *Pelycodus*. *Conorycthes* has two inferior incisors, and is represented by several species. *Esthonyx* has three inferior incisors. It is



Esthonyx Burmeisteri.

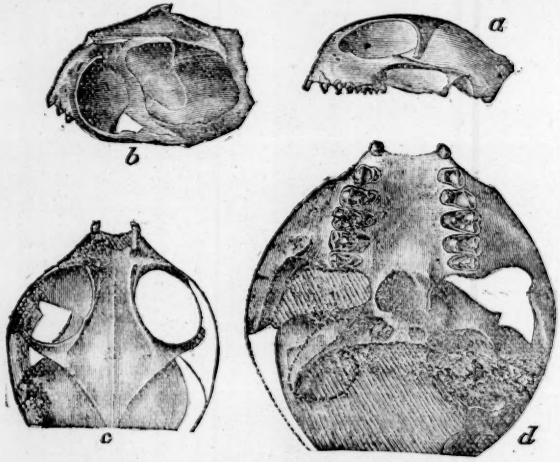
remarkable for having the scaphoid and lunar bones separate, which is not the case with existing Hedgehogs. Four species are known. Another Bunotheroid suborder is named *Mesodonta*,—animals characterized by approaching the Quadrumana in proportions, but the rami of the mandible are separate, so that they also approximate towards Lemurs. Several allied forms occur in the Eocene of France, and it gradually became manifest that these

animals differ, more than was at first supposed, from existing types. But the author is unable to separate the group from the Insectivora by ordinal characters. Eleven genera are comprised in this tribe, among them being *Microsyops* with two species; and



Hyopsodus vicarius.
a. Premaxillary and maxillary. *b.* Mandible.

Tomitherium closely allied to *Adapis* of Cuvier, but having two incisor teeth instead of three. *Tomitherium* is an animal with slender limbs and elongated femora, and the limbs generally have much of a quadrumanous character, and these resemblances are supported by those of the lower jaw and teeth; but in the form of the humerus there is resemblance to Lemurs. The only species is *T. rostratum*. *Pelycodus*



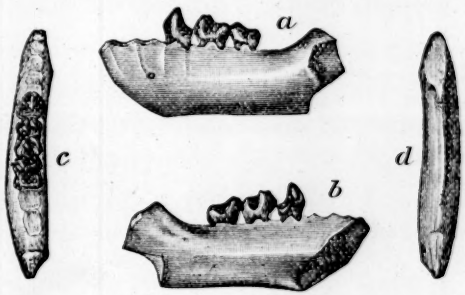
Anaptomorphus homunculus. Nat. size.
a, b. Side views. *c.* From above. *d.* From below.

is distinguished from *Tomitherium* by having the third trochanter in the middle of the shaft; and it has two roots to the second premolar. Other characters are shown in five species described. *Sarcolemur* is an allied genus, distinguished by having acute cusps on the heels of the true molar teeth. *Hyopsodus* is known from the mandibles of five species, and is distinguished by the simple inner tubercle, with cusps at the angles of the heels of the molars.

The Prosimiæ are distinguished from the Mesodonta by having an opposable hallux which does not exist in the genus *Pelycodus*. The author states that *Chiromys* represents a primary division of the

Bunotheria, with a position between the Prosimiæ and the Tillodonta. There are probably three families of these Eocene Lemuroids, but there is some uncertainty as to whether the allies of *Adapis* belong to this or to the preceding group, so that the author limits his description to the Mixodectidæ and the Anaptomorphidæ.

Mixodectes is only known from mandibles, so that some uncertainty exists as to its systematic position as well as its dental formula, and the anterior teeth may be incisor, canine, and premolar, or the incisor tooth may be absent. Two species are known. *Cynodontomys* is also founded on mandibles; and *Anaptomorphus* complete the family. The latter genus, of which we give figures of the natural size, has large well-defined orbits. There is no sagittal crest, and the temporal ridges are well defined. In many ways the cranial characters approximate towards the Lemur *Tarsius*, yet the dental formula agrees with the Indrisinæ, but no known Lemur has premolar teeth with similar interior lobes and cusps, which resemble those of the higher Monkeys and Man. The small size of the canines is quite human. The cerebral hemispheres and brain are not smaller than in the genus *Tarsius* or in typical existing Lemurs. From the way in which quadrumanous and definite lemuroid characters are combined, the author suggests that this type may represent the



Anaptomorphus æmulus. Left mandible twice nat. size.

family from which true Monkeys and Men were developed. The European type which most closely resembles this is *Necrolemur*; but in that genus the two inferior premolars have but one root. *Anaptomorphus æmulus* was about as large as a Marmoset. *A. homunculus* is founded on the cranium. It was rather smaller than *Tarsius spectrum*, and is thought to have been nocturnal; with feeding habits like the smaller Lemurs of the Malay Islands and Madagascar.

The Creodonta is a large division of Mammals with the scaphoid and lunar bones separate, narrow cerebral hemispheres having very large and exposed olfactory lobes; while the ankle joint is generally not trochlear. The separation of the scaphoid and lunar bones in the carpus is a distinction from the Carnivora, yet the articulation of the lower jaw with the squamosal bone is transverse, as in Carnivores. The ilium is suggestive of the Insectivora and Marsupials. The femur has a third trochanter. The astragalus articulated with the

cuboid and navicular bones. There were five toes on the hind feet, in which the terminal digits are compressed and sharp. On the whole, in the limited number of incisor teeth it approaches the Insectivora; it has many affinities with the Prosimiæ and some affinities with Lemurs, and is more distantly connected with the Carnivora. The Creodonta differed from the Carnivora in the small size of the limbs as compared with the head. Many of the species are thought to have been aquatic. In Europe the group is represented by such types as *Arctocyon*, which has commonly been regarded as a Marsupial. In this suborder six families are included, comprising about twenty-seven genera. Among these genera the author would look for the ancestors of the existing Carnivora. The genera with marked inner cusps and tubercles to the molar teeth are nearest to the Marsupials. The genera without internal tubercles to the molars are regarded as ancestors of the Hyænodontidæ; the family Miacidæ are the forerunners of the Dogs; and the family Oxyænidæ were the forerunners of the Cats. It will thus be seen that this large group is worthy of careful study. The genus *Ictops* agrees closely with *Didelphys*; but there are only three upper incisors, and the angle of the mandible is not inflected. *Peratherium* agrees in dental characters with *Didelphys*, and is only retained until the complete dentition is known. *Triisodon* is characterized by the simplicity of the fourth inferior premolar, and the rudimentary anterior cusps of the molar teeth; from a study of its teeth the author concludes that the posterior milk molar of Diphyodonts is a permanent tooth in the Marsupialia. Four species exemplify the characters of this type. *Deltatherium* is a genus which has in the lower jaws two tubercular sectorial teeth, and a third behind them with a long heel. It has three premolars and a well-developed canine. The dentition is similar to that of the Opossums. *Didelphodus* differs from *Deltatherium* in having an additional premolar in the lower jaw.

Stypolophus is represented by ten species. *S. viverrinus* is about the size of the domestic Cat. Its skull is remarkable for the lachrymal bone not extending posterior to the large lachrymal foramen. The genus is found in the Phosphorites of France, but the author does not follow Gaudry in uniting it with *Proviverra*, because the fourth upper premolar has an internal cusp and an external cusp, flanked in front and behind by a basal heel.

The Miacidæ comprise two genera, *Miacis* and *Didymictis*. *Miacis* is conspicuous for its canine characters, among which marsupial affinities are said to be no more prominent than in the case of other Creodonta; while *Didymictis* makes an approximation towards *Oxyæna* in its dentition. It is well represented by seven species. The Oxyænidæ comprise *Pterodon*, *Protopsalis* and *Oxyæna*. Characters of the skull are suggestive of Cats, but the head was larger and limbs smaller than in true Carnivora, and they rather resemble the Carnivorous Marsupials in proportions. This type is supposed to have been aquatic. *Mioclænus* comprises about eight species, known from their dentition, which affiliates the genus to *Arctocyon*; but it is distinguished by the single tubercle on the inner part of the crown

of the upper molars. Enough of the skeleton of *M. ferox* is known to show that its nearest living ally is probably *Thylacynus;* but it differs from Marsupials in having a patella. It is about as large as a Sheep. The remaining American genera of Creodonts are *Dissacus*, *Sarcothraustes* and *Mesonyx*. The latter genus has some resemblance to *Hyænodon*, but more to *Amblyctonus*. The claws are flat like those of Seals; but the structure of the ankle suggests that the type was not exclusively aquatic. *Mesonyx* is thought to have lived on Turtles.

M. ossifragus was as large as a large-sized American Black Bear with the fore-limbs much shorter than the hind-limbs, giving much the aspect of a huge Rabbit, except that the tail was long. It was one of the largest Eocene flesh-eaters.

In this review we have attempted to give some idea of the varied organization comprised in the Bunotheria. The conception of this group is the most original contribution to mammalian classification which has been made for a long time. The group is almost as difficult to realize, as would be a conception of the Marsupialia, if Marsupials were only known in a fossil state. Some exception may be taken to the term order, by which the Bunotheria is indicated, for the group is rather a lower division of the placental subclass; which the author would compare to the Marsupialia in the variety of organization it includes, while he believes it to have developed simultaneously with the Marsupials, or even to have been an older group. The classification has necessarily grown out of the affinities which the described families of Mammals have with each other, rather than with surviving groups; and although we cannot pronounce a decided conviction on the importance of this great generalization without an examination of the specimens on which it is founded, the principles on which it is evolved are sound. If we recognized the Creodonta and other groups as allied to existing orders of Mammals, but distinguished by their smaller brains, and less specialized organization, then the existence of the Bunotheria becomes not only a convenience in classification, but a generalization which will direct research. H. G. Seeley.

(*To be continued.*)

II.—Catalogue of the Blastoidea in the Geological Department of the British Museum (Natural History), with an Account of the Morphology and Systematic Position of the Group, and a Revision of the Genera and Species. By Robert Etheridge, Jun., and P. Herbert Carpenter, D.Sc., F.R.S., F.L.S. 4to. pp. xiv. and 322. Illustrated by Twenty Lithographic Plates and Twelve Woodcuts. (London, 1886, Printed by Order of the Trustees.) Price 25*s*.

WE know not whether it be due to the beneficial effects of transplantation, but there has certainly been a steady issue of publications in connection with this Department since its removal, in 1880, from Great Russell Street, Bloomsbury, to the new soil of Cromwell Road.

A penny Guide to the Geological Galleries appeared on their re-opening to the public on 19 April, 1881, followed by an illustrated edition in 1882 (price threepence); a third followed in 1884; and a fourth edition (price fourpence) in 1886. Of the three earlier editions altogether 11,234 copies have been sold. A Guide to the Fossil Fishes appeared in 1885 (price threepence). A Catalogue of the Fossil Foraminifera, by Prof. T. Rupert Jones, F.R.S. (8vo.), appeared in 1882 (price 5*s*.). A Catalogue of the Fossil Sponges, by Dr. G. J. Hinde, F.G.S., 4to. with 38 plates (price 30*s*.), in 1884. A Catalogue of the Fossil Mammalia (8vo.), Part I., by Richard Lydekker, B.A., F.G.S., was issued in 1885 (price 5*s*., with thirty-three woodcuts); Part II. also in 1885 (price 6*s*., with thirty-nine woodcuts); Part III. in 1886 (price 4*s*., with thirty woodcuts); (Part IV. we are informed is now passing through the press). A Catalogue of the Palæozoic Plants in the Geological Department, by Mr. R. Kidston, F.G.S. (8vo. pp. 288, price 5*s*.), appeared in 1886.

The present work was commenced by its authors some years since, but their task was delayed by the necessity to collect materials which might serve to illustrate in detail the minute structure of this curious and extinct group of Echinodermata. They were soon fortunate in obtaining the co-operation of Mr. Charles Wachsmuth, of Burlington, Iowa, a gentleman who has devoted some twenty-five years to the collection of Crinoidea from the Carboniferous rocks of North America, and who has also published several important memoirs on these organisms. With his aid, and that of numerous other friends in Europe and America, the authors have been enabled to examine probably the largest and most instructive collection of these organisms ever brought together, thus rendering the comprehension of their minute anatomy comparatively easy, and giving one confidence in the interpretation which they offer of each detail of their structure.

With regard to the systematic position of the Blastoidea, one of the authors (Dr. P. Herbert Carpenter) has had peculiar advantages in approaching the subject, from his previous studies of the Crinoidea collected by the "Challenger" expedition; whilst both authors have long and patiently studied the fossil forms, and have endeavoured by the examination of numerous remains and by the preparation of very many sections, exhibiting internal structure, accurately to work out the morphology of this obscure and but little understood group.

The position of the Blastoidea in relation to the rest of the Echinodermata has long been a subject of grave discussion; but the leading authorities are now agreed in giving the Blastoids a position as a group equivalent in rank to the Brachiate Crinoids and the Cystids, or to the Urchins and Starfishes.

Blastoids with stems appear to be extremely rare, although there is little doubt that the great majority were stalked forms. Indeed the authors figure several examples (see plate iii. fig. 16; pl. v. fig. 25; pl. vi. fig. 23; and pl. xvi. fig. 7) showing the remains of stems. But the stem in *Granatocrinus* is of moderate size compared to the diameter of the flat basal disc of which it occupies the centre.

In *Pentremitidea*, *Orophocrinus*, *Cryptoblastus*, and *Troostocrinus*

the basal cup is elongated and tapers elegantly downwards until its narrow lower end rests directly upon the first stem-joint, which is sometimes seen still united to the base. One Pentremite has been obtained by Mr. Wachsmuth, in which the stem terminates below in a branching root like that of the *Bourgueticrinidæ*: whilst three genera of Blastoids, namely, *Pentephyllum*, *Eleutherocrinus*, and *Astrocrinus*, appear to have had *no stem* in the adult state, whatever may have been the case during their early life.

The following definition of the Pelmatozoa[1] (under which name the stalked Echinodermata are classed by the authors) will probably give the leading characters of this difficult group more clearly than any words of our own :—

"Phylum Echinodermata, Branch Pelmatozoa. Echinoderms which are fixed either permanently or temporarily by the middle of the aboral surface. A jointed stem containing a neuro-vascular axis is usually present, but may be lost when maturity is reached; or, in the case of a few sessile forms, remain altogether undeveloped. The apical system consists of a dorsocentral plate, basals, and radials, with the frequent addition of under-basals and interradials. These plates form a cup, which either simply supports, or more or less completely encloses, the visceral mass, and often bears jointed appendages—the arms and pinnules.

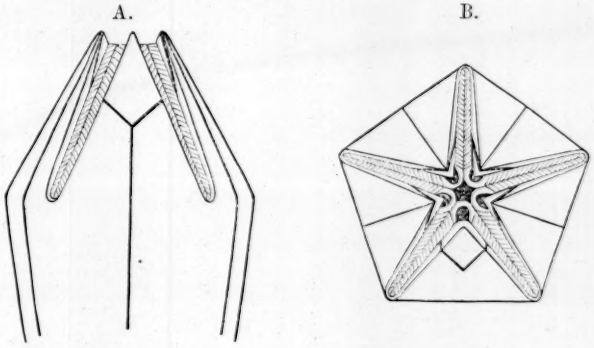


Fig 1.—Diagram of *Troostocrinus Reinwardti*. A. the anal side. B. the summit view. The radio-deltoid sutures are shown by rather darker lines.

"An oral system, which is to some extent a repetition of the apical system, and consists of a central plate, basals, radials, and interradials, is developed to a very variable extent above the actinal surface of the larva. It may be (1) altogether resorbed; (2) persist as basals only which cover the peristome; or (3) reach a high state of development so as to form a complex vault or *tegmen calycis* covering in the whole visceral mass. The anal tube opens on the oral surface, but is sometimes in close relation with the calyx-plates.

"The water-vascular ring does not communicate directly with the exterior, and the lateral branches of the radial vessels (when present) are respiratory, but not locomotor in function."

[1] From πέλμα, πελματος, stalked, and ζῶον, animal.

"Class Blastoidea.—Armless Pelmatozoa of a pyriform, clavate, ovate, or globose shape, which usually exhibit a very perfect radial symmetry. Base monocyclic, of two large plates and one small one, the latter being always in the left anterior interradius, Fig. 2. II. (A–B). Five radials, more or less deeply incised by the ambulacra, and five interradials which rest on them and bound the peristome, one of them being pierced by the anus. For view of summit, see Fig. 1, B. p. 421.

Ambulacra fringed on each side by a single or double row of jointed appendages, which are in close relation to the side plates. These rest on or against a subambulacral lancet-plate, which is pierced by a canal that lodged the water-vessel and unites with its fellows into a circum-oral ring.

Hydrospires arranged in ten (or rarely eight) groups which are limited to the radial and interradial plates; their slits are parallel to, and more or less completely concealed by, the ambulacra, often opening externally through pores at their sides, and also by five or ten openings round the peristome. Neither hydrospires nor ambulacra extend below the basiradial suture.

Peristome naturally concealed by a vault of small plates, which rarely exhibit any definite arrangement, and are continuous with the covering-plates of the ambulacra."

From the foregoing definition it will be seen that the Blastoids differ in certain important points from other Pelmatozoa, notably in the perforation of the lancet-plate, "of which we have as yet no knowledge whatever in either Crinoids or Cystids. The absence of under-basal plates and the constant presence of five interradials (one of which is divided in *Elæacrinus*), lastly the constant but peculiar trimerous symmetry of the base, only observed in the rare

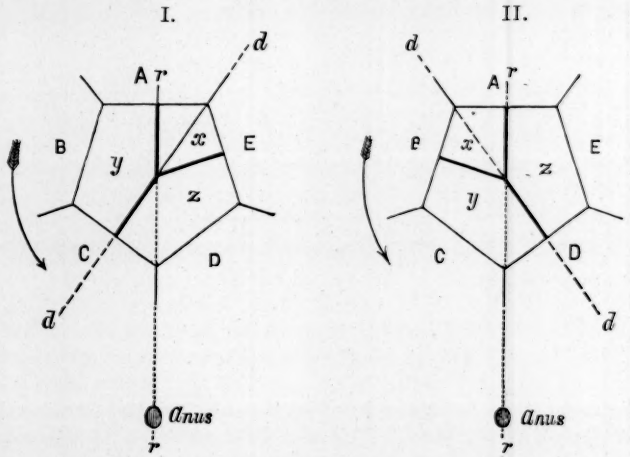


Fig. 2.—Diagram showing the arrangement of the basals in I. *Platycrinus*, and II. in the Blastoids. *A*, *B*, *C*, *D*, *E*, the five radii of the calyx. *x*, the small azygos basal. *y*, *z*, the two larger basals. *d* . . . . *d*, the dorsal axis. *r* . . . *r*, the radial axis, in which the anus is situated. The arrows show the (probable) direction of the spirally-coiled digestive tube.

Cystid, *Cryptocrinus cerasus*, and possibly in one Crinoid (*Stephanocrinus*). Many Palæocrinoids have a trimerous base, but according to Wachsmuth and Springer ("Revision of the Palæocrinoidea," pt. iii. 1885, p. 10), the small plate is always in the right anterior interradius (A—E). (See Woodcut, p. 422, Fig. 2, I.)

The calyx of many Blastoids is marked by very well-defined ridges, which start from the bottom of the basal cup and extend upwards until they meet the radial lips at the distal ends of the ambulacra. The general arrangement of these ridges is the same in all Blastoids, and is perhaps best studied in *Stephanocrinus* in which type they are very strongly marked (see Woodcut, Fig. 3, *infra*).

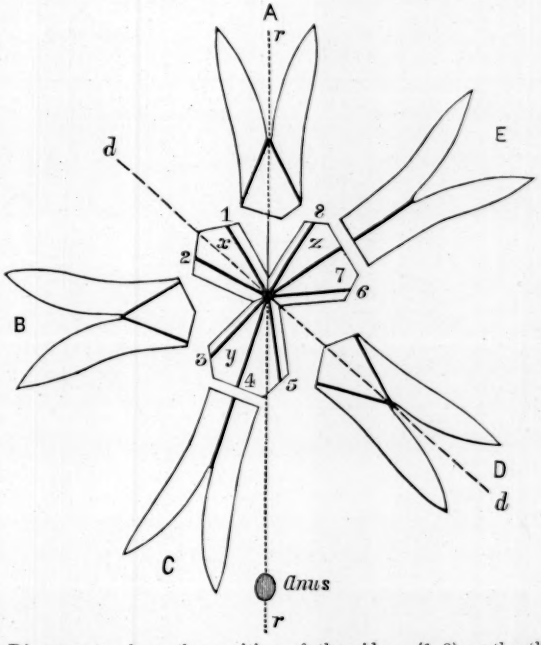


Fig. 3.—Diagram to show the position of the ridges (1-8) on the three basals and the five radials (*A, B, C, D, E*) of *Stephanocrinus angulatus* (modified from Roemer). (The lettering of the plates is the same as in Fig. 2.)

Lastly we may notice the very symmetrical grouping of the hydrospires. "These organs occur in most Cystids, and perhaps even in some Crinoids, but we know of no member of either group in which their arrangement is at all like that which occurs in the Blastoids. In this class they are restricted to the radial and interradial plates, where they lie with their slits parallel to the ambulacra, and except in the genus *Codaster*, there are always five interradial pairs of hydrospire-groups. No Cystid whatever presents anything like this regular distribution of the hydrospires, which often extend down on to the basals, and even on to the under-basals, when such are present."

"Considered as a whole, the Blastoids have the most regularly

constructed calyx of any Pelmatozoa, and in fact of any Echinoderms. Under-basals may occur in all the brachiate forms, while the basals of Crinoids may vary in number from two to five, and the development of the interradials varies extremely among the different groups." (p. 119.)

There is a persistent number of thirteen plates in the Blastoids, with the single exception of *Elæacrinus*, which has the posterior deltoid divided into two by the anal plate; and with the exception of three genera, *Eleutherocrinus*, *Astrocrinus*, and *Pentephyllum*, the

Echinodermata.		Upper Silurian.	Devonian.						Carboniferous.			
Branch Pelmatozoa. Class Blastoidea.	No. of Species	America.	America.	Britain.	Belgium.	Germany.	France.	Spain.	America.	Britain.	Belgium.	Germany.
Order Regulares, E. and C.												
Pentremitidæ, D'Orb.												
Pentremites, Say	49	...	...	...	..	...	...	...	*	...	...	...
Pentremitidea, D'Orb.	18	...	*	?	*	*	...	*	...	...	...	?
Mesoblastus, E. and C.	7	...	...	...	...	...	...	...	*	*	*	...
Troostoblastidæ, E. and C.												
Troostocrinus, Shumard...	2	*	...	?	...	...	?	?	?	...	...	...
Metablastus, E. and C.	7	...	...	?	...	...	?	?	*	...	...	...
Tricœlocrinus, M. and W.	5	...	...	...	...	...	...	...	*	...	...	...
Nucleoblastidæ, E. and C.												
Elæacrinus, Roemer	9	...	*	...	...	...	...	...	...	...	...	...
Schizoblastus, E. and C....	10	...	?	...	...	...	...	...	*	*	...	...
Cryptoblastus, E. and C.	3	...	...	...	...	...	...	...	*	...	...	...
Acentrotremites, E. and C.	1	...	...	...	...	...	...	...	...	*	...	...
Granatoblastidæ, E. and C.												
Granatocrinus, Troost	10	...	?	...	...		...	...	*	*	...	...
Heteroblastus, E. and C.	2	...	...	...	...	...	...	...	*	*	...	...
Codasteridæ, E. and C.												
Codaster, McCoy	15	*	*	*	...	...	...	...	*	*	...	...
Phœnoschisma, E. and C.	7	...	...	...	...	...	...	*	?	*	*	...
Orophocrinus, von Seebach	9	...	..	...	...	...	...	..	*	*	*	...
Cryptoschisma, E. and C.	2	...	...	...	...	...	...	*	...	...	...	...
Order Irregulares, E. and C.												
Astrocrinidæ, T. and T. Austin.												
Astrocrinus, T. and T. Austin ...	2	...	...	...	...	...	...	...	...	*	...	...
Eleutherocrinus, Shum. and Yand.	3	...	*	...	...	...	...	...	...	...	...	...
Pentephyllum, Haughton	1	...	..	...	...	...	...	...	...	*	...	...
Total	162											

contour of the calyx is always perfectly symmetrical, consisting as it does of five equal and similar radials, and five deltoids of the same nature.

The foregoing table (from p. 136) is extremely valuable as showing the Distribution of the Genera of the Blastoidea in Space and Time. We have added a column with the probable number of species referred to each genus.

From the foregoing list, it will be seen that only two (American) generic forms, *Troostocrinus* and *Codaster*, occur in the Upper Silurian, about six or seven genera in the Devonian; whilst the great majority occur in the Carboniferous series both in England and in America.

A careful description of each species is given by the authors, illustrated by twenty quarto plates and 399 figures, most beautifully and accurately drawn by Messrs. C. Berjeau and P. Highley, requiring not only great artistic power, but a large store of patience in making out such minute and very elaborate details.

All Biologists who are interested in the Echinodermata must feel grateful to the authors of this very elaborate and exhaustive Memoir, which clears up so many points in the anatomy of this ancient class, that has hitherto been but very imperfectly understood.

We trust they may be so well satisfied at the favourable reception which this volume is sure to meet with, that they will take up and work out in the same earnest and painstaking manner the still more important and interesting Brachiate division, which has remained far too long neglected by palæontologists.

III.—Catalogue of the Fossil Mammalia in the British Museum (Natural History), Cromwell Road, S.W. Part III.[1] Containing the order Ungulata, sub-orders Perissodactyla, Toxodontia, Condylarthra and Amblypoda. By R. Lydekker, B.A., F.G.S., etc. 8vo. pp. xvi. & 186. (London, 1886, printed by Order of the Trustees.)

THE present part of Mr. Lydekker's Catalogue of the Fossil Mammalia completes the order Ungulata with the exception of a single group, the Proboscidea. This group, it is announced, will form Part IV. of the Catalogue, which is now in the press. Although embracing only a small section of the Mammalia, this part is of special interest to the palæontologist; for out of the eighty species recorded in its pages, all are extinct save four, namely, *Tapirus Americanus, Equus caballus, Rhinoceros sondaicus* and *Rh. unicornis*. Furthermore, of the seventy-eight extinct species, no fewer than thirty-two species, belonging to as many as twelve genera, date back to the Eocene Tertiary formation, namely, *Lophiodon* (5 species); *Hyracotherium* (3 species); *Pachynolophus* (4 species); *Palæotherium* (8 species); *Anchilophus* (2 species); *Rhinoceros* (2 species); *Cadurcotherium* (1 species); *Periptychus* (1 species); *Haploconus* (1 species);

[1] Part II. was noticed in the Geological Magazine, April, 1886, pp. 175-177.

Coryphodon (1 species); *Tinoceras* (2 species); and *Dinoceras* (2 species)—represented in the collection.

The genus *Lophiodon* nearly approaches the Tapir and Rhinoceros in the structure of its teeth. Like the Tapir the lower true molars have simple transverse ridges, but the premolars are more or less longitudinally tuberculated, and in this respect it differs from its near ally, the *Palæotherium*, in which the whole series of the lower molars are longitudinally bi-crescentic in form. It had also, like the Tapir, which it preceded in geological time, four toes on the fore-feet and three on the hind-feet.

Many species are enumerated, ranging in size from the Pig to the Rhinoceros. Their remains have been met with in several localities in Europe, and also in this country, in Eocene Tertiary strata.

Its dentition may be expressed as follows:—

Incisors $\frac{3}{3}$, canines $\frac{1}{1}$, premolars $\frac{3}{3}$, molars $\frac{3}{3}$, $\times 2 = 40$.

Hyracotherium was a small animal, about the size of a Hare, principally known in a fossil state by its dentition. Its remains are comparatively rare and have been found in the Lower Eocene (London Clay), Herne Bay; at Kyson in Suffolk; and also as a derived fossil from an older deposit in the Suffolk Crag.

Pachynolophus is an allied genus of small animals, whose remains are only found in Eocene deposits. Four species are represented in the collection by teeth and jaws from France and Switzerland. The dentition is *complete*, viz.:—

Incisors $\frac{3}{3}$, canines $\frac{1}{1}$, premolars $\frac{4}{4}$, molars $\frac{3}{3} \times 2 = 44$.

Palæotherium is well represented in the collection. It was a Tapir-like animal, first described by Cuvier, from skulls, teeth and bones, of numerous individuals, representing several species, which were discovered in the Gypsum quarries (Upper Eocene) of Montmartre, Paris.

Palæotherium magnum was as large as a Horse, four or five feet in height; whilst *P. curtum* was about the size of a Hog. They all had a short fleshy snout or proboscis, like the Tapir; but, unlike the Tapir, they had only three toes on each foot, whilst the Tapir had four toes on the fore-foot.

Mr. Lydekker (following Prof. Flower) treats *Paloplotherium* as identical with *Palæotherium*. *P. annectens* was about the size of a Sheep and is well represented in the collection from the Upper Eocene of Hordwell, Hants, and from Vaucluse in France.

Anchilophus, a small Palæotheroid, is represented by jaws and teeth from the Upper Eocene at Bembridge, Isle of Wight, and from Vaucluse and Caylux in France.

The Rhinoceroses are now all placed in a single genus, which includes five or six known living species. No fewer than twenty-four species are represented by fossil remains in the collection, mostly from Pleistocene, Pliocene or Miocene Tertiary deposits; but two forms, *Rh. croizeti* and *Rh. lemanensis*, occur in the Upper Eocene phosphorites of France, thus carrying this remarkable living genus back in time to the older Tertiaries. Four other genera, of which at

present we possess only imperfect materials for study, are provisionally referred to the family *Rhinocerotidæ*, namely: *Hyracodon*, *Cadurcotherium*, *Homalodontotherium* and *Elasmotherium*. Of these four genera, one only (*Cadurcotherium*) dates back to the Eocene period.

Periptychus and *Haploconus* are both Lower Eocene genera from New Mexico in North America. They are characterized by the grooved and ridged sculpture of the teeth. They form a part of the suborder Condylarthra, in which are placed a number of those primitive Mammals having a bunodont or lophodont type of cheek-dentition, foreshadowing both the Artiodactyla and Perissodactyla; there are usually five digits in both the manus and pes, the terminal phalangeals being acuminate. The best-preserved example of the family is the genus *Phenacodus*, of which a figure was given in the Geological Magazine for February, 1886 (Plate II. p. 49).

Under the suborder Amblypoda is placed the remains of the genus *Coryphodon*, from the Lower Eocene of Harwich, Essex, and from Dulwich, near London. It also occurs in the Eocene of France and North America.

Coryphodon was the largest of the early Eocene Ungulates, and the relative smallness of its brain, together with its five-toed feet, which resemble in structure those of the Dinocerata, indicate some affinity to that group, which it also preceded.

The section Dinocerata is included in the same suborder, and completes the series of Eocene Mammals represented in the collection.

We are indebted for our very perfect knowledge of the genera *Tinoceras* and *Dinoceras* to Professor O. C. Marsh, whose labours in exploring the Eocene Tertiary deposits of the Wyoming Territory have opened up an entirely new chapter in Tertiary palæontology.

For a full account, with figures, of these interesting genera, see the Geological Magazine for May, 1885, Decade III. Vol. II. pp. 212–228 (with 18 Woodcuts).

The fore and hind limbs had feet with five well-developed toes, each terminating in a hoof; the femur and tibia were placed vertically in a line, as in the hind-leg of the Elephant. The nasal bones were elongated, having two small pre-nasal bones in front of them; the animal does not appear to have been furnished with a proboscis.

The most striking feature is the skull, which is surmounted by three pairs of rounded protuberances or horn-cores, which were probably enveloped in horny sheaths. There are no upper incisors, but the upper canines are developed into large and powerful flattened tusks, directed downwards, and protected on each side by the broadly-expanded margin of the lower jaw.

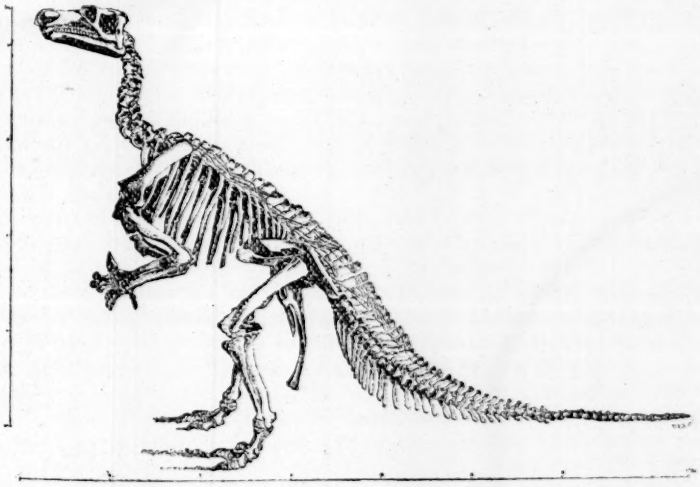
These early Eocene types have so important a bearing upon the question of the derivation of our existing Mammalian fauna, that we cannot but welcome every addition to our knowledge concerning them, and we have to thank Mr. Lydekker for this further instalment of his Catalogue, and to express the hope that we may soon have it before us in its completed form.

IV.—British Museum Guide to the Department of Geology and Palæontology. 4th Edition. (1886, Printed by Order of the Trustees.)

IN this neat little volume (which contains 117 pages of text and 49 excellent woodcuts) the amateur palæontologist can obtain for the small consideration of fourpence a concise synopsis of the chief divisions of the Animal Kingdom. The greater portion of the book, which has been written by Dr. Henry Woodward, F.R.S., Keeper of the Department, with the aid of his valuable Assistant the veteran Mr. William Davies, F.G.S., of the same Department, is devoted to the Vertebrata, and since the Fossil Fishes have been treated of in a separate 'Guide,' attention is mainly concentrated on the Mammalia, Aves, and Reptilia; the Amphibia coming in for a more limited notice. The Mammalia are divided into the following 12 orders:—Primates, Carnivora, Insectivora, Chiroptera, Dermoptera (*Galeopithecus*), Rodentia, Ungulata, Sirenia, Cetacea, Edentata, Marsupialia, and Monotremata. By far the largest space is assigned to the Ungulata, which is split up into the Proboscidea, of which the Museum contains the finest collection in the world; the Hyracoidea, at present unknown in the fossil state; the Amblypoda, containing the *Coryphodon*; the *Dinocerata*, represented by a fine series of casts presented by Prof. O. C. Marsh; the *Condylarthra*, a primitive group of five-toed forms from the Eocene of N. America; the *Toxodontia*, which includes the peculiar Rodent-like *Typotherium* of S. America; the Perissodactyla; and the Artiodactyla. We may especially notice in this order the excellent figures illustrating the difference in the structure of the molars of the African and Indian Elephants, and also those showing the characteristic dentition of the existing *Hippopotamus* and of the extinct species from the Siwalik Hills of India. A special feature in the Ungulate collection is the series of skulls of the peculiar group of ruminants from the Pliocene of India and Greece, comprising the *Sivatherium*, *Bramatherium*, *Hydaspitherium*, and *Helladotherium*, which appear to connect the modern Deer with the Antelopes, and are more or less closely related to the existing Giraffe. The Museum possesses the type skull of the first-named genus, while of the second and third genera casts of the skulls have been respectively procured through the courtesy of the Council of the Royal College of Surgeons and the Director of the Geological Survey of India. Full justice is also done in the work to the splendid collection of Edentata from the Post-Tertiaries of South America, and of Marsupials from those of Australia; and we are glad to notice a good figure of Sir R. Owen's *Tritylodon* from the Secondary strata of South Africa, for which we believe Dr. Woodward is indebted to the courtesy of Prof. E. D. Cope, of Philadelphia. The remarkably fine skeleton of Steller's Sea-Cow (*Rhytina*), which was recently acquired for the Museum, is also figured, and compared with that of the existing Manate. Seven pages are devoted to the class Aves, and include figures of *Archæopteryx*, *Hesperornis*, *Odontopteryx*, and *Dinornis*. Save in the table of contents, no mention is, indeed, made of the subdivisions of the class, and this is perhaps wise,

since it is very difficult to make its divisions accord in importance with those of the other vertebrate classes; we think, however, that it will be advisable eventually to rank the divisions of Carinatæ, Ratitæ, and Saururæ as orders, and to relegate to the rank of suborders the so-called orders into which the Carinatæ are divided by students who confine their attention to existing forms.

Pages 70 to 87 are assigned to the Reptilia, and we note with satisfaction the classification which has been adopted in this difficult class, as being one of the best that has come under our observation. The orders adopted are the Pterosauria, Crocodilia, Dinosauria, Anomodontia, Ichthyosauria, Ophidia, Lacertilia, Plesiosauria, and Chelonia. The divisions of the second order proposed by Prof. Marsh are adopted with a subordinal value; while the Anomodontia includes the Theriodontia, Dicynodontia, Rhynchocephalia, Cryptodontia, Endothiodontia, and Placodontia. According to this arrangement it will be necessary to retain Prof. Dollo's group of the Simædosauria for *Champsosaurus*, since that genus seems more distinct than *Endothiodon* from the typical Rhynchocephalia; we should, however, have preferred to have placed the last-named genus in closer proximity to that suborder. In the Lacertilia the *Mosasauridæ* are ranked merely as a family, which avoids the necessity of the introduction of Prof. Cope's Pythonomorpha. In this class there are figures of *Rhamphorhynchus*, *Pterodactylus*, *Dimorphodon*, *Iguanodon*, *Megalosaurus*, *Ichthyosaurus*, *Plesiosaurus*, *Megalania*, and *Chelone*.



Skeleton of *Iguanodon Bernissartensis*, Boulanger (restored after Dollo) from the specimen in the Brussels Museum.

The Invertebrates occupy pp. 92-107, but as the notice of these classes is necessarily brief, we need not refer further to them on this occasion. The last page of the text mentions the extensive collection

of Fossil Plants, which is not yet arranged; and also calls attention to the valuable series of type collections now in course of arrangement. Since the latter includes the collections of Dr. William Smith, Mr. S. V. Wood, J. and J. de Carle Sowerby, Mr. F. E. Edwards, and Dr. Thos. Davidson, their interest to all palæontologists must be of the greatest. The volume concludes with an excellent plan of the Palæontological Galleries and a well-arranged Index.

With the publication of this series of popular "Guides" for the nonscientific, and of the "Catalogues" for the scientist, the British Museum is rendering its unrivalled collections of the best possible advantage to all classes of visitors; and we beg to offer our hearty congratulations to Dr. Woodward and his able coadjutors on the successful completion of the present "Guide" to one of the most interesting branches of the whole collection.

REPORTS AND PROCEEDINGS.

Zoological Society of London.

June 29th, 1886.—Osbert Salvin, Esq., F.R.S., V.Pres., in the chair.—The following communication was read:—

"Note on the Presence of a Columella (Epipterygoid, Parker) in the skull of *Ichthyosaurus*," by A. Smith Woodward, F.G.S. Communicated by the President.

In this paper, the author recorded the presence of a "columella" (epipterygoid) in the skulls of several Liassic Ichthyosaurs in the British Museum, and offered a brief account of the main features of the bone. The communication was suggested by Sir Richard Owen's statement ("Foss. Rept. Lias Form." p. 96) that he had observed no trace of the element in question in the British fossils; and the fact became still more worthy of note, since Prof. Cope (Proc. Amer. Assoc. Adv. Sci., vol. xix. p. 200) had already determined the presence of a columella in the skull of an American Ichthyosaur, and this circumstance was evidently overlooked by Sir Richard Owen. As pointed out by Prof. Cope, the bone is long and slender, with expanded extremities; and in the present communication the author showed that it was a distinct element, although a suture at its upper end in the American specimen appeared to be wanting. It was further remarked that the lower extremity of the Ichthyosaurian columella exhibits a striking resemblance to its homologue in *Sphenodon*, in the fact that the expansion shows two distinct articular facettes upon its inner aspect as is well seen in the specimen figured in Hawkins' "Book of the Great Sea-Dragons," pl. 19, fig. 1. In the living Rhynchocephalian genus, the articulation is contracted both with the pterygoid and an inward extension of the quadrate; in *Ichthyosaurus*, however, its nature cannot yet be determined, and, according to Prof. Seeley, there is no inwardly-directed process of the last-named bone.

Erratum.—Geol. Mag. August, 1886, p. 341, legend to woodcut, for "Interior," read *Exterior*.

ON THE TERM NEOCOMIAN.

Sir,—When my article on the use of the term Neocomian appeared in this Magazine, I felt conscious that I had provoked a formidable antagonist, and when I saw Prof. Judd's long letter in the July Number, I felt like the captain of a frigate about to receive the broadside of a three-decker; but it seems to me that the utmost damage I have received is a few shot through my sails, and that the hull of my little vessel is left perfectly water-tight.

A large part of Prof. Judd's letter is devoted to showing that I was mistaken in crediting him with being the first to apply the term *Neocomian* to British strata, and he says that the author who had the chief honour (as he esteems it) of introducing that term was the late Mr. R. A. Godwin-Austen. Well, this is perfectly true. I admit that Godwin-Austen was the first to use the term; in 1843 he employed it for what we now call the Atherfield Clay of Surrey, and in 1856 he speaks of the "Lower Greensand or Neocomian group;" but in the first paper (Proc. Geol. Soc. vol. iv.) he correlated the Surrey clay with the *argile ostréenne* of the Vassy section, and in the second he makes the Lower Greensand of North Wilts correspond with the *Urgonien* of D'Orbigny. Now subsequent researches proved these correlations to be erroneous. Renevier and Marcou, writing in 1856 and 1858, showed that the English Lower Greensand was not the equivalent of the *Neocomien* or of the *Urgonien*, but of the *Rhodanien* and *Aptien*; consequently the use of the term in England, having originated in a mistake, ought to have been abandoned.

So indeed it might have been but for the intervention of Prof. Judd, who is certainly responsible for its revival in 1864, and for urging its more extended application in 1870. His article "On the use of the term Neocomian" (Geol. Mag. Vol. VII. p. 220) was written with the special object of recommending the adoption of the term for the whole series of beds between the Gault and the Jurassic strata, and of raising this series to the rank of an independent system. I maintain therefore that if Prof. Judd had not introduced this name for the second time, it is highly probable that it would never have found a place in British nomenclature.

Prof. Judd next refers to Godwin-Austen's arguments for the Neocomian age of the Lower Greensand fossils. I repeat that by the increase of our knowledge these arguments have been shown to be fallacious; of course the fossils of the Lower Greensand resemble those of the Urgonien more than those of the Gault and Chalk! if it were otherwise, we should class the Lower Greensand with the Upper and not with the Lower Cretaceous rocks. If Prof. Judd cannot formulate a better reply to the arguments adduced by me on p. 318 of this Magazine, I think I may look upon my case as proved.

I am told that "scientific names go through a struggle for existence," and that the fittest survive; maybe they do, but in my opinion the name Neocomian is not yet out of the struggle, and has not yet definitely found its proper place. Surely, Sir, geology is a

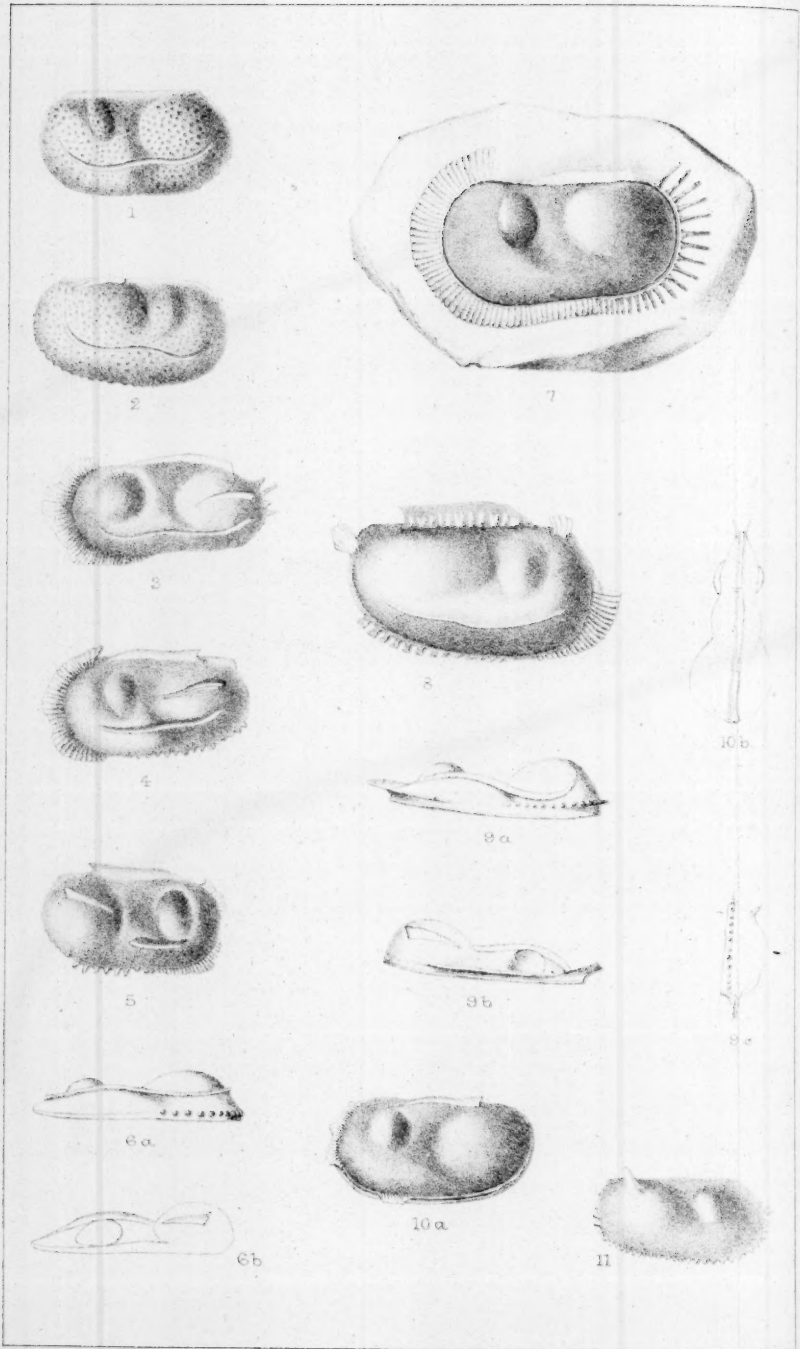
rapidly progressive science, and our nomenclature is always undergoing modification; old names must sometimes be limited or dropped, and new names must be created as the progress of knowledge demands. Why in point of fact Prof. Judd and I are actually discussing the desirability of dropping an old name (Lower Greensand), and of finding another to take its place; he prefers to borrow a foreign term and to extend its application; I point out the objections to this plan and prefer to use a new name altogether. Let us argue the matter clearly and fairly, and then leave the readers of this MAGAZINE to decide between us, but I do not see why my opponent should deprecate the idea of my "formulating a new nomenclature" for the Cretaceous rocks either in my private or official capacity.

Lastly, let me offer Prof. Judd my hearty thanks for drawing my attention to the passage which he quotes from Dr. Fitton, and which I had been careless enough to overlook. I am delighted to find myself anticipated by so great a master as Fitton, and to be relieved of the responsibility of introducing a new name; it is remarkable that Fitton should have foreseen the very want which has since arisen and I feel that I shall have a much stronger case in referring to the term *Vectine* or *Vectian* as his proposal, suggested in 1845, and revived by myself in 1885. A. J. JUKES-BROWNE.

August 10.

ON A REMARKABLE SECTION IN DERBYSHIRE.

SIR,—During the meeting of the Warwickshire Field Club at Matlock, we visited a remarkable sandpit at Longcliff, four miles S.W. of Matlock Bath, on high ground near Brassington. Our attention was drawn to this by Mr. Howe, of Matlock, as one of the most interesting geological features of the district. The section exhibits a series of variegated and highly coloured sands and clays, here and there containing a few pebbles of small size, chiefly of white quartz and in places lignite. These are not pebble-beds at all resembling the ordinary 'Bunter pebble beds,' nor do I remember any Bunter section showing such a peculiar succession of variegated sands and clays. They lie in a trough or hollow of the Carboniferous Limestone, and there are several other smaller pits in the same neighbourhood and under similar conditions, though not sunk at present to any great depth; at Longcliff the total thickness is thirty feet. The sands and clays are of various colours, yellow, white and red, and in some cases a dark vermilion, giving a very remarkable appearance to the section. Lithologically they resemble the variegated sands and marls in the Tertiary (Middle Bagshot) series, especially at Alum Bay in the Isle of Wight; and the question is whether they should be assigned to the Bunter or the Tertiary, and if they should prove to belong to the later period, I believe it is the first remnant of the kind recognized in Derbyshire. The occurrence of lignite leads to the possibility of this deposit being of Tertiary age: but of course no absolute decision can be given without further investigation, which Mr. Howe has promised to undertake. This pit was opened after the visit of the Geological Survey to Derbyshire, so that the section was not exposed at that time. P. B. BRODIE.



J. W. K. del.
E. C. Knight lith.

West, Newman & Co. imp.

Carboniferous Ostracoda.